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ABSTRACT

Addressed to individuals in higher education who are concerned about the application of information and data processing technologies to problems in college and university administration, instruction, and research, the 43 papers in the collection are concerned with such topics as the nature of new information technology; the use of information technology in institutional resource management and program planning; institutional strategies for document preparation and information dissemination; information technology applications for student recruitment and enrollment activities, fundraising and alumni relations, and monitoring and controlling institutional energy costs; word processing for instructional and research purposes; developing a computer-literate faculty; access to specialized educational resources through computer systems; national and regional resource sharing organizations; the impact of computer technology on library organization and staffing; the use of computers for library circulation and inventory management; information technology and the storage and use of library holdings, with special attention to document delivery, remote access systems, and networking and national bibliographic databases; and contrasting views on the role of computer and information technology in institutions of higher learning. (JL)

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Solving College and University Problems Through Technology

edited by Donna Davis Mebane

EDUCOM

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Preface

Colleges and universities face a myriad of problems and pitfalls as they look to the eighties. The often discussed problems of enrollments, inflation, energy, increased accountability, decreased funding, etc. are not solved easily, and they require a range of imaginative and innovative responses. Educational institutuion must use all available tools to meet the challenges facing them. One of the most powerful of these tools is information technology. This book provides readers with an excellent picture of creative uses of technology and future opportunities in the adminstrative, academic, and library areas of higher education.

Revised and edited for publicaton, these papers were originally presented at the EDUCOM Annual Conference in Atlanta, Georgia, October 1 - 3, 1980. James C. Carmon, Director, Office of Computing Activities, University of Georgia, served as Conference Chairman. He was ably assisted by a conference committee that included: Weston Burner, Massachusetts Institute of Technnology; James C. Emery, The Wharton School, University of Pennsylvania; Carolyn P. Landis, EDUCOM; J. Charles Morrow, University of North Carolina; Louis T. Parker, Jr., North Carolina Educational Computing Service; and James Powell, Oberlin College.

Fred C. Davison, President of the University of Georgia gave the keynote. The opening plenary session was led by Frederic Withington, Vice President, Arthur D. Little, Inc., and Elizabeth L. Young, President of the Public Service Satellite Consortium. Speakers in the closing plenary session were Ronald Brady, Executive Vice President, University of Illinois, Howard

Resnikoff, Director, Division of Science Information & Technology, National Science Foundation, and Richard Van Horn, Senior Vice President and Provost, Carnegie-Mellon University.

The opening chapters in this proceedings focus on new technologies. Papers in subsequent chapters present examples of the use of technology to address: (1) Administrative areas such as student recruitment and enrollment, fund-raising and alumni relations, and monitoring and controlling energy costs; (2) Academic concerns such as document preparation, developing a computer literate faculty, access to specialized resources, and local networks; and (3) Library issues such as automating circulation systems, inventory management, using technology to store and use holdings, and networking and national bibliographic data bases in libraries.

The book should be a valuable resource for individuals in higher education who are concerned about the application of technology to significant problems in college and university administration, instruction, and research.

John W. McCredie
President, EDUCOM

OVERVIEW

1

The Computer: One of Educators' Major Tools for Tomorrow

Fred Davison, University of Georgia

Much of higher education as we have traditionally known it in this country may be becoming outmoded and inappropriate for the 1980s. As a consequence, colleges and universities are undergoing dramatic and sweeping changes in almost every facet of their operations. These changes, whether we like them or not, are inevitable, and they fundamentally alter long-held notions about teaching and learning. The changes revamp, and in some cases totally restructure, procedures and formats for many administrative functions. At the heart of these changes is what Dr. Philip Handler, President of the National Academy of Sciences, has called "the principal tool that our civilization has developed to mitigate the condition of man." That tool is technology.

Very few people think that technology per se is bad. But there have been — and remain — fears about the impact of technology on society. Some critics have attributed to technology many ills of modern society including congested cities, polluting automobiles, radiation contamination and the like. Some claim that technology has contributed to moral decline and a softening of national will by leading us to believe that machines can solve all our problems. At the other extreme are those who worry that machines are "taking over the world." These doomsayers see computers one day becoming the masters and humans the robots.

Such critics have been around almost as long as technology itself. As philosopher Eric Hoffer wrote, "From the early days of the Industrial Revolution, intellectuals of every sort predicted that the machine would make man superfluous." Hoffer says it would be hard to find a social scientist "who does not believe that automated machines and computers are eliminating man as a factor in the social equation."

There is no doubt some degree of validity in such fears. But the fact is, the evidence is powerful and overwhelming that the United States — and all advanced nations — owe much of their progress and development to technology. From the invention of the compass and the printing press in the 17th century, to the steam engine in the 18th century, to electricity and applications of thermodynamics in the 19th century, to atomic energy, space rockets and computers in the 20th century, technology has been the catalyst for most of mankind's landmark endeavors.

In an address to an international symposium on science, technology and the human prospect last year, Dr. Chauncey Starr, Vice Chairman of the Electric Power Research Institute, made this assertion: "Science and technology have continually relieved the limitations on man's ability to live in the circumstances provided by nature, and they continue to do so." Dr. Starr pointed out that science and technology have enabled us to increase food production; accommodate to harsh climates; transport and communicate goods, services and ideas; increase, and most wisely use, our resources; and live longer and in better health. Rather than a threat or a menace, technology can be a force for progress and for good. The key is that we control technology, and channel it into productive and useful purposes. And of all the ways in which we can use technology, few are more important or far-reaching than educational applications.

This paper discusses educational technology in three contexts: the general impact of technology on education — both the advantages and the disadvantages; the marriage of education and technology first in the classroom and now throughout the campus; and the many exciting technological applications that are either now in use or just on the horizon.

In 1978 and 1979, the journal *Educational Technology* presented a lengthy series of profiles on technology in higher education. Part of this series focused on developments in electronic communications, or telecommunications. Following are a few of the predictions about how telecommunications will impact colleges and universities in the remainder of this century.

- Greater and greater amounts of information will be stored in computerized data banks. That information will become increasingly accessible at decentralized locations throughout campuses.
- Communications systems will help to reduce sharply the amount of both travel and paperwork now entailed in educational operations.
- There will be substantial increases in the amount and variety of material — particularly educational material — that is available on home television screens.
- Television sets as we know them will be replaced by home terminals that will incorporate TV reception along with videotape, videodisc playback and data display.
- The cost of all these technologies will eventually be lower than the cost of conducting certain education business in the way we do it now.

According to the authors of the series, "These developments will affect the content, the methods and the economics of education. Educators will have no choice other than to adapt to a changed world." The prospect of this technology revolution in education is tremendously exciting. But the transition to technology will not be without problems. In the short term, there will be difficulties in adapting traditional notions about teaching and learning to the sterile and impersonal machine. The transfer to technology will inevitably mean loss of jobs, or the reassignment of personnel to new kinds of work. The quality of instruction will probably become more uniform. But the price will be more vigilance to assure that the quality is high. Teacher training will have to be altered radically to prepare instructors to work with the technologies and to assess how students respond to the new formats. And perhaps the biggest problem, initially at least, will be the expense. The start-up dollar costs may be staggering. But of all the potential problems, expense is one that is almost certain to meliorate in time.

The long-range ramifications of the shift to technology are somewhat harder to foresee. Christopher Dede, President of the education section of the World Future Society and a staff member at the National Institute of Education, made some predictions in a speech last year to officials of state schools. Dr. Dede thinks that eventually training — which he terms "limited range of right answers" — will be done by machine, while educating — or "multiple right answer learning" — will be done by people. This may mean that machines will teach such subjects as reading and math while people continue teaching such things as creative writing. Intelligence may have to be defined differently, Dr. Dede suggests. The use of machines for instruction may require that human intelligence be judged by capabilities or capacities other than those that historically have been used. To communicate with other people through machines, new kinds of communications skills may need to be developed. Dr. Dede thinks we might study successful media personalities to learn how they communicate social presence over the airwaves.

Other developments predicted by Dr. Dede include: centralization of curriculum development and finances; new government regulations to permit interface with public utilities; new teachers who are challenged by the idea of working with technology; and a vastly increased awareness and understanding among people of both the strengths and weaknesses of technology.

As Dr. Dede, and many other scholars, make clear, the move to technology can be both a blessing and a curse. While there will be enormous benefits, there will also be headaches. "Such an outcome," says Dr. Dede, "is typical of using technology to solve problems. Unless carefully monitored, the side effects from a 'technological fix' can be worse than the original situation." "Nonetheless," he adds, "our society continues to expand its technological capabilities, and this in turn compels educators to move in the same direction."

How has this momentous change in direction for higher education come about? The January 1980 issue of the journal *Instructional Innovator* provides a brief review of the development of educational technology in the United States.

The seeds were sown with the growth of that mainstay of every American home, television. In 1946, 8,000 homes had TV sets. A decade later, two-thirds of all households in the country had them. Now of course, it's becoming rare to find a house with just one set. Radio was already commonplace, but in 1954 the appearance of transistorized radios announced the miniaturization of electronic hardware. The transistor made possible the design of compact equipment that put more capability in smaller units — an innovation refined even further by the integrated circuitry developed in the 1960s. Color television also appeared in 1954. Later refinements in broadcasting and receiving equipment made for greater fidelity in picture reception.

Within the last decade, video-cassette player-recorders and prerecorded videotapes for home use have appeared. Viewers can even buy equipment to produce their own programs. A more recent development is the videodisc which offers such features as freeze-frame and random access. All of these video devices can be viewed on screens with diagonal dimensions of six feet or more.

Radio sound fidelity has been greatly enhanced by improvements in phonographs and speakers. Phonographs have advanced from models that played only 78 rpm records to the present stereo systems. Tape recorders became almost commonplace overnight when reel-to-reel models were supplanted by casette recorder-players. Sound is now being transmitted digitally, by converting sound into numbers, achieving reproduction of near-perfect accuracy.

Most of these innovations in audio and video are due to continuing developments in microelectronics — a science that gave us the ubiquitous electronic calculator. Similarly, the microprocessor has been responsible for a revolution in computers. By enclosing a number of miniaturized central processing units in one package, scientists have dramatically reduced the size of computers, while improving their capabilities, and decreasing their costs.

In the years following World War II, to accommodate returning military veterans and later the children of the "baby boom", teachers sought ways to get more information to more people more efficiently. They began turning to some of the new technological marvels. Films, filmstrips, and simulations found their way into the classroom. Foreign languages were taught with the use of tape recorders. Overhead projectors became popular. And the television set appeared.

America's great adventure into space also resulted in some giant leaps forward for education. Technology from the space program has benefitted society in incalculable ways. The proliferation of satellites, and advances in microelectronics, are but two examples.

Just as important was a national commitment not to let this country take a back seat to the Soviet Union in the technology race. The 1958 National Defense Education Act provided the means for developing new curricula in math and science, and for modernizing science and language laboratories. The act also provided training to help teachers learn to use the new equipment and techniques.

The eagerness of both the public and the education community to bring technology into the classroom, and the early availability of government financial help, provided fertile ground for the growth of what we now call educational technology. And grown it has.

As the author of the *Instructional Innovator* article sums up: "Technology's exponential growth is inescapable, its potential mind-boggling. . . Even if economic or other factors were to slow the pace of change, there is no reversing the accomplishments that have been won. Each invention, each imaginative adaptation, branches into a multiplicity of new avenues for further development, and yesterday's marvels become the necessities of life in today's technological society."

Where has this great technological leap forward put us? Where do we stand today and what still lies ahead? Any discussion of educational technology must begin with the computer. Widely hailed as a time and energy-saving miracle, sometimes damned as a menace to mankind's sanity and society's serenity, the computer, according to communication specialist Ralph Lee Smith, "lies at the heart of the information explosion that has overtaken world society in the last half of the 20th century."

Smith, writing in *Educational Technology,* says that without computers, the information explosion "would be substantially out of control." Many experts, he adds, consider the computerization of information "the most fundamental change in our ways of accessing, storing and using knowledge since the invention of printing."

In pure economic terms, computers are one of the "best deals around" for educators. The cost of computers for all purposes continues to drop while their capabilities rise. The large-scale integration in circuitry has likewise lowered the cost of computer hardware. A computer that cost $300,000 in the 1950s can be built for $1,000 in your basement. The logic component of a microcomputer can be built for less than $5. The range of jobs computers can perform is enormous, and growing every day. From 24-hour "electronic bankers" to electronic mail, from rapid word processing on computerized keyboards to long-distance facsimilie transmission, from satellite-linked videoconferences to the so-called communications "superhighways," computers make possible technology that is reshaping the way we conduct our daily lives.

Computers play a part in virtually every undertaking on today's college and university campuses. They are mainstays of science laboratories and research units. They have become indispensible for instruction in disciplines as diverse as journalism and environmental design, social work and zoology, law and forestry. Students are part of computerized record keeping systems from the time they apply for admission until they graduate. Then they go into the alumni computer system.

This quarter, the University of Georgia is putting into operation a new computerized registration system. The system will both speed the process and cut the cost of enrolling students in classes. (See article by Bruce Shutt, The University of Georgia Registrar.)

Computers have also had tremendous impact in the library area. Automation is perhaps the most significant development in library science since the Dewey Decimal System. At the University of Georgia, we are moving toward a fully automated library system (See the article by David Bishop, The Director of Libraries at the University.)

Some critics have charged that the educational community is not prepared for the influx of computer technology, and in fact is resisting such innovations. But from all my indications at the University of Gerogia and many other campuses across the nation, computers are being extensively used in many creative and productive ways to improve and facilitate education in our colleges and universities.

If computers are commonplace, television is virtually universal. Experts say that most Americans get most of their information from television and radio, and unquestionably, television holds great opportunities for educators. In a 300 page report issued last year, the Carnegie Commission on the Future of Public Broadcasting said, "The potential of television and radio for learning is only beginning to be explored and exploited." With the rapid advance of technology, the commission said, "It is clear that with careful planning, skillful execution and thorough evaluation, telecommunication will play an increasingly fundamental role in the learning processes of Americans of all ages and backgrounds."

The possibilities of television as an educational tool are almost endless, but in this article I'll concentrate on public television. College and university licensees operate 56 of the 150 public broadcasting facilities in the United States. These licensees spend a large portion of the money spent on public broadcasting programming. Last year, the chief executive officers of 24 colleges and universities met with government officials and electronic communications executives to explore some of the problems and potentials of public television. Federal Communications Commissioner Tyrone Brown put the topic in perspective when he told the educators that their stations are more than training facilities or mediums for formal instruction. "The reasons why your institutions are uniquely suited to hold broadcast licenses," Brown said, "is that you can use them to extend the university's intellectual and creative resources, in all their diversity, beyond the confines of the immediate campus."

The conference delved into such questions as whether public television should broadcast actual formal course material; whether college and university stations should use their unique resources to produce more programming for the Public Broadcasting System, how much coverage should be given to community affairs; how to meet the high costs of maintaining and operating modern, state-of-the-art television facilities; and how to define the role of facility members in telecommunications.

No precise and clear answers were offered for these issues. But there was general consensus that colleges and universities have not put their public television capabilities to best use, in part because of uncertainty of purpose and lack of planning and coordination. This is regrettable, given the vast potential of television. Those of us with public television licenses should work to assure that these stations, in the words of Donald K. Smith, Senior Vice President of the University of Wisconsin, help make "learning an integral part of living."

An associated, but often overlooked, medium is radio. The average American household has six radio receivers, and the average American listens to radio three hours a day. About 750 radio stations in the U.S. are licensed to colleges and universities. Again, the potential for educational purposes is great. Some examples include:

- Purdue University, where students have earned more than 8,500 hours of college credit through radio courses.
- Five colleges in West Virginia which have developed a program to provide listeners with a baccalaureate, or even a master's degree, using only radio-based instruction.
- Albany Medical School in New York which uses an FM station to broadcast technical medical information to some 70 hospitals and nursing homes in six northeastern states.

Radio as an educational tool is less expensive than television, telephone, film, print or recordings. Given its economy, its accessibility and its demonstrated effectiveness, radio clearly is a resource of immense value and usefulness. Educators should take full advantage of it.

Much of the new technology available to higher education interfaces with — and largely exists because of — two of the devices just discussed — computers and television. Associated technologies include cable TV, satellite technology, videotape, and videodisc.

Cable TV now serves about 20 percent of U.S. TV households, and is expected to be in half of all American homes by 1990. New systems with 30 or more channels and two-way capability, offer exciting possibilities for educators, both in transmission of instructional material and in production of specialized programs to meet local needs.

Examples of educational uses of cable TV include:

- Oregon State University broadcasting credit courses from 7:30 a.m. to 10 p.m. four days a week over a local cable system.

- One channel of a cable TV system in Columbus, Ohio, being used exclusively for certificate and credit courses offered through Columbus area colleges.
- Three California institutions participating in a project in which senior citizens take instruction, sometimes for credit, in the use of portable video equipment. Then they make videotapes that are broadcast over the local cable system.

Cable TV owes much of its boom in the last few years to the advent of domestic communications satellites. These satellites make possible the distribution of cable programming from a central origination point to cable systems throughout the country.

Public television stations are now linked by satellite. National Public Radio is transmitted by satellite. Several major publications, including *The Wall Street Journal* and *U.S. News and World Report,* are published simultaneously at sites around the country through the use of facsimile images transmitted by satellite.

On the horizon are satellites that will make it possible to receive and send data, voice, facsimile and video through one system. And eventually, satellites will transmit directly to home receiving discs, bypasssing both local stations and cable systems.

Aside from their interface with cable TV, use of satellites for educational purposes is still largely in the experimental stage. A satellite has beamed in-service credit courses for teachers throughout the Appalachia region. The courses were offered by a group of 15 colleges and universities. Stanford University and Carleton College in Canada used satellite transmission to share graduate courses in communications technology. Schools in Washington, Montana, Idaho and Alaska shared medical education and training with a satellite.

Two of the newest innovations are the videotape recorder and the videodisc. Recorders can record, store and play back programs through standard TV sets. They can also play prepackaged videotapes or videotapes made with home equipment.

Videodiscs are more compact and less costly than videotapes, but they only play back, and cannot record. Both, however, could be used by students in libraries, residence halls or at home as supplements to classroom presentations.

Almost all of these advances involve computers. The computer itself has undergone dramatic changes in recent years because of improvements in circuit integration. All the parts of an entire circuit — transistors, diodes, resistors, capacitors and their connections — can now be processed onto a silicon chip one-sixteenth of an inch square. This technology has made possible minicomputers and microcomputers. Besides being much smaller than conventional computers, these devices are also much less costly and thus more accessible.

Satellite communications are now carried through digital transmission, in which the information is translated into a binary system. At its destination, the information is decoded back to its original form. Digital transmission is becoming standard for all types of communications systems. A recent improvement in this technology is called data packet switching, in which digitalized transmissions are broken into "packets" of information. The packets are transmitted independently, then electronically reassembled at the destination. The advantages of this system are high speed and sharply lowered costs.

Each of the devices and systems discussed so far can, by itself, significantly enhance the ability of educators to transmit knowledge. But when these technologies are coupled or combined, the prospects border almost on the fantastic.

Some possibilities suggested by Dr. Dede are:

— An independent television programming system, delivered to the home on cable television, that would include entertainment and a curriculum based on motivational and developmental psychology. Top-flight actors, using proven marketing techniques, would create and deliver programs with instructional messages designed for varying age groups. Dr. Dede terms this idea a "Sesame Street-plus approach."

— Computer assisted home instruction, in which portable computers, calculators and microprocessors use many different programs and data sets to teach such topics as history, demographics and law. This approach would actually eliminate classrooms and lectures. Library and textbook functions would even be programmed into calculators. Though fiscal savings would be great, this kind of instruction also sacrifices the human element — a loss which would have to be considered carefully.

— Sophisticated computer games, delivered to many home TV sets by a giant central computer. Players would communicate with the computer by home keyboard — and eventually by voice. The range of responses would be unlimited. Any response would elicit a message from the computer, challenging creative and cognitive skills. Research has shown non-educational TV games to be highly motivating. There is no reason to think creatively devised educational games would be any less engrossing.

— And finally, the coupling of an interactive microcomputer with videodisc images and soundtrack, to produce filmed material for individual learner response. The program would be structured to let the learner draw conclusions and test them before receiving new plot material. The initial costs of producing such programs would be high, but once the programs are available, the cost of using them would be minimal.

There are other possibilities. For example, electronic mail, computer conferencing, and computer searches for data availability and retrieval. Deaf people can now enjoy television, thanks to a process known as captioning. This allows words printed on a TV screen to be seen by a viewer with a special decoding device. Computers now have braille terminals for blind people. A special kind of typewriter that meshes a teletype with a computer terminal allows speech and hearing-impaired people to communicate. They can send typed messages over a telephone, and the messages are printed at the receiving end on a terminal. There is even a machine that converts printed material into synthetic English speech.

The array and sophistication of available technology is almost beyond comprehension. What the future holds is beyond even imagination. But it is clear that education as we have delivered it for years in our colleges and universities is being changed forever by technology. It's also true that in order to cope with the technological tidal wave, in education and in all other aspects of our lives, citizens must become better informed about technology.

A scholar reviewing the National Academy of Science 1979 report titled "Science and Technology: A Five-Year Outlook," makes this assertion: "Science and its practical applications have so permeated everyday life that those citizens who are unable to handle basic information will no longer be full participants in society."

We must teach technology, as well as use it. We must make certain that our students understand the use and benefits — and the drawbacks — of technology. We should help them to know how it will influence and affect their lives. But, we must keep sight of our real purpose — helping to create and pass on knowledge. The English author and statesman Joseph Addison said of education, "It is a companion which no misfortune can depress, no crime can destroy, no enemy can alienate, no despotism can enslave. At home a friend, abroad an introduction, in solitude a solace and in society an ornament. Without it, what is man?" Our purpose is education. We can use computers and electronic wizardry. Or we can use a simple book and a pencil. The point is not so much HOW we educate. The point is THAT we educate. For indeed, without education, what is man?

NEW TECHNOLOGIES

2

The Promise of Future Technology

Frederic G. Withington, Arthur D. Little, Inc.

We are all familiar with the incredible pace of improvement of data processing hardware. Most of us are also familiar with the much slower pace of software improvement, the snail's pace of standards development, and the peculiar fact that data processing expenditures seem to keep rising in the face of declining hardware costs. These conflicting factors make it a little tricky to assess the promise of future technology, but fortunately a variety of organizations have been sufficiently concerned to sponsor research in the area. One of these is Harvard University, for which Arthur D. Little, Inc. recently conducted a study of possible future administrative information systems to 1990. This paper is based on that study, and contains excerpts which Harvard kindly authorized from the study's final report.

This paper (and the study) did not directly address data processing in research or instructional areas. In research, projecting the potentials in a given discipline is often fairly straightforward but generalizing across all disciplines is impossible. In instruction the potentials are subtle and varied; even specialists have difficulty preparing forecasts with any precision.

For brevity and clarity we summarized our forecasts of the relevant technologies into a description of an "ideal system," one which Harvard can reasonably expect to completely implement by 1990 if it chooses to. This system was tailored to meet Harvard's needs, which are of course different from those of most other colleges and universities. However, many of the characteristics of the "ideal system" are broadly applicable.

The system is described from the viewpoint of the user. The tools available to the user are described first (the devices available, plus the supporting services). After the user's tools are described, the networks and central facilities necessary to provide the services are presented. Each of the descriptions is accompanied by cost estimates (in 1980 dollars; no explicit allowance for inflation has been made).

1. The User's Tools

Five kinds of user tools are provided by the system. The first two are personal (i.e., located at or near the work place of each member of the faculty and staff requiring one). The remaining three are "local," available to groups of users in sufficient numbers to provide convenient access, but not generally dedicated to individuals (in the manner of convenience copiers now).

1.1. The Display Telephone

This hypothetical device is about twice the size of today's telephone. It contains a conventional telephone handset, a small keyboard containing both alphabetic and numeric keys, and a flat panel display of approximately 3" x 5" dimensions. It is designed to substitute for the present telephone instrument, being located in the same place and plugged into the same connector.

The first function of the display telephone is to provide voice telephone service. The voice service will be comparable to today's, with some additional features available such as the following:

— Call forwarding — the user will be able to enter into his display telephone a number corresponding to any other telephone, and then the system will transfer incoming calls to it.

- Automatic answering — either when signaled by appropriate keys or automatically (based on counting the number of times a telephone has rung without being answered), the call will be transferred to another location for answering. Alternatively, the call may be transferred to an automatic answering device like those available today. The automatic device may be used as backup for the central answering location, if it does not answer either (e.g., if an incoming call is received outside of working hours when no one is present).
- Conferencing — from the keyboard on the display telephone, the user will be able to interconnect any number of other telephones into a conference call network.
- Voice-responsive directory and dialing — the system will be able to recognize the spoken name of anyone affiliated with the University (faculty, staff or student). Upon recognition, the system can provide either the telephone number for the person or ring the person's instrument directly. Other voice-responsive services may be provided which are more advanced than this, depending on the state-of-the-art ten years from now. It seems certain that at least the directory and dialing functions will be available.
- Central dictation — the user will be able to record material in a central file for subsequent transcription (such systems are available now). In addition, the keyboard of the display telephone can be used to specify an addressee for the dictated material. The addressee can be a secretary or the person for whom the voice message is intended. The recipient's display telephone will then indicate that a message is waiting; by dialing the appropriate number he can have it delivered. The voice-responsive directory can be used as an alternative to the keyboard, permitting ordinary public telephones to be used for voice message origination.

In addition to telephone service, a display telephone will support message services. Each instrument will contain several hundred characters of digital storage, enough to store several messages of moderate length. If the information to be stored exceeds the capacity of the display telephone, automatic "spillover" to a central storage will be provided. A message can be originated at the keyboard of any display telephone and delivered to any other (or others) by dialing them, and stored in the receiving display telephone(s) for subsequent review by the recipient(s).

Finally, the display telephone can be used as a simple terminal for retrieval of information from both public and private information collections. During the 1980's, we expect that public information services will evolve in the United States (they have already begun in several European countries), which will provide a wide variety of current information of general interest in the form of brief messages for display on a simple terminal such as the display telephone. In addition, many individual departments will want to implement local collections of useful information, messages and notices which can be scanned or selectively retrieved using display telephones.

Precursor devices to the display telephone are beginning to appear on the market. During the 1980's, we expect display telephones to become very popular; we estimate that the cost of a display telephone in the late 1980's will be approximately $200 per unit (1980 dollars). This compares to a 1980 price of about $100 for a purchased telephone.

1.2. Document Creation and Retreival Station

The hypothetical document creation and retrieval station looks much like today's general-purpose computer terminal, but its capabilities by 1990 can be expected to include the following:

- The station will be fully graphic for both input and output. This means that with the incorporation of appropriate software, it can be adapted to any alphabet, system of notation or to the creation and display of any graph, chart or image in monotone or color. By 1990, a wide variety of software packages should be available for the handling of many systems of notations and graphic "languages" which will dedicate keys on the keyboard to appropriate sets of symbols and functions enabling the user to create documents or records for electronic storage. The station will offer processing capabilities for editing text, formatting pages and images and in general assisting in every step of the process of preparing a document for printing (which can be done after preparation of the document, either via transmission to a formal printing facility or via the local "communicating copier" described below).

— The document creation and retrieval station will also serve as a terminal for the searching and retrieval of data bases and files, again exploiting its graphic capability for handling specialized alphabets, notation systems and images. The station itself will have a storage capacity of about 200 text pages of information, sufficient to store the full text of modest size documents that are being worked with, or selections of documents transmitted from a central repository following a search process conducted interactively from the station.

— The station will also be able to serve as a computer terminal for programming and computational purposes (indeed, its internal processor will be powerful enough to execute many computational procedures without requiring any external connection).

— Finally, the document creation and retrieval station will incorporate the functions of the display telephones described above. This will obviate the necessity for an individual to have both instruments.

Computer display terminals are now available for less than $1,000 apiece, but with much less capability than this. Their costs are not likely to decline much because the costs of the display mechanism, keyboard, enclosure, power supply, etc., are not subject to the kind of price reduction expected for the electronic components. We, therefore, expect that the document creation and retrieval station of 1990 will still cost approximately $1,000, but with the much larger quantities of electronics and the software required for these functions incorporated at that price.

1.3. Communicating Copier

The communicating copier should appear much like today's medium speed convenience copiers. However, the communicating copier will be an all-digital device capable of transmitting and receiving digital representations of pages read at the input station or to be printed at the output station. Containing a computer with appropriate software, it can also edit the material passing through and add to it, if desired (e.g., it can create the form within which variable information is to be printed). It will serve the following functions:

— It will serve as a convenience copier, editing the material being copied, if desired, according to programs stored in it.

— It will serve as a local printer, supporting the other tools of the user, such as the document station and display telephone described above (printer mechanisms of the required capability are expected to be too costly even in 1990 to be dedicated to individual user terminals). With high speed (approximately 2 seconds per page), high quality and fully graphic output capabilities, the communicating copier will provide the paper copies needed of work prepared by the user at the document station or retrieval from collections elsewhere. Naturally, remote communicating copiers belonging to others may be used to print material in addition to the local one.

- It will serve as the local printer for any kind of communication from a remote point: computer output, material retrieved from archives, and telecommunications messages will be handled with equal convenience.
- It will serve as a facsimile transceiver, so that the contents of paper pages can be transmitted between communicating copiers located anywhere. Transmission speed will be at the two second per page capability of the machine, or longer if the transmission line between the two machines is inadequate to support full speed operation.
- It will also be a page digitizer for input to computer-based files. In this application, typewritten or graphic material can be converted to digital codes for storage and subsequent display on a selective basis. (Since many thousands of characters of computer storage are likely to be required for each page digitized, it will probably be impractical to consider the storage of very large archives. However, it will be practical to store thousands or tens of thousand of pages.)

Such devices are expected to cost approximately $8,000 in 1990. This price may seem relatively high considering the fact that convenience copiers are now available for as little as $3,000. However, a communicating copier with all of the functions listed above will require a large quantity of very high speed digital electronics. Simpler versions with less than the full capabilities outlined above (and most particularly, with lower speeds) are likely to be available at lower prices.

1.4. Administrative Mini-Systems

This system, like the communicating copier, will be a local system serving a number of users within a single department, center or small school. It will support up to 10 or 12 directly connected terminals, each of which will serve an individual.

The administrative mini-system will look much like today's small business computer system; indeed, except for increased breadth of functions and price-performance, it will be comparable to today's small business systems. Its purpose will primarily be to maintain the administrative files supporting an administrative entity within the University, to collect transaction data originating locally, to communicate transaction data as necessary with other systems and with the central system of the University, and to support a limited set of other communications and processing functions, if desired. More specifically, it will do the following:

- Through the terminals, it will support interactive entry of all transactions affecting students, faculty and staff, finances, and the user of facilities.
- These transactions will be entered via the terminals attached to the administrative mini-system. The terminals will include whatever means are convenient for reading magnetic identification cards, optically readable enrollment and schedule documents and the like, so as to minimize the transaction keying workload of the personnel in the using organization.
- The administrative mini-system will contain all of the files and administrative and planning information appropriate to the entity using it. It will remain possible to have these files maintained at the University's central facility as they are now, and some of the smaller organizations may prefer the central alternative. However, the low cost of the administrative mini-system and the requirements of most users for fast response data entry and reporting will probably lead most users to opt for local files on a local system.
- The administrative mini-system will be very easy to use, providing report preparation and inquiry facilities so simple that most regular users in the University will spend a few hours learning how to specify requirements for the system, then obtain for themselves whatever individualized reports and special runs of data are required to support planning and decision making. We

feel quite confident in this forecast, because the ease of use of such interactive small systems has already reached a point where many thousands of ordinary users without specialized programming training have proved willing to deal with the systems directly.

— In addition to supporting administrative functions, the administrative mini-system will be capable of acting as a controller for various types of communication devices having limited speeds and capabilities. The administrative mini-system will be able to perform text processing, though at a lower level of sophistication and speed than the document creation station. It will also be able to serve as a controller for connecting display telephones to both local and remote networks, and to handle low speed facsimile transmission of page images. A very small school, department or center may then build its entire system around a single administrative mini-system, obtaining limited versions of all the services at a lower total cost than a larger entity which can justify the high speed, specialized devices.

The cost of the administrative mini-system will vary widely, depending on the power needed in the processor, the size of the files to be stored, and the number and mix of terminals to be supported. A relatively small version of the system with 4-6 terminals, a file of 10^7 characters, a low-speed printer, and a communications interface may cost on the order of $15,000 in 1990, with larger systems costing more.

1.5. Teleconference Classrooms

The teleconference classroom is simply a room of whatever dimensions and layout appears appropriate, provided with equipment to support remote communications. This equipment will vary somewhat, but will typically include one or more large screen television displays and monitors, cameras to originate video signals, multi-channel audio equipment sufficient to provide the illusion of conversion taking place within the room, and a communicating copier to provide instantaneous communication of written materials or visual aids appropriate to the material being employed.

Such rooms will ordinarily be used for video-assisted instruction, most often without remote communication links being needed. However, with appropriate connections to communication services they can serve both instructional and conference purposes. We envision that by 1990 a substantial number of educational and business institutions will support such teleconference rooms, and others will be available on a rental basis (as Picturephone® centers are now available from AT&T). Used mostly for instructional purposes, they will also be available for meetings in connection with development activities, conversations with staff at remote facilities, presentations of proposals for research grants, and a variety of other purposes.

We envision the equipment cost for such a teleconference classroom to be approximately $25,000 in 1990 plus installation of appropriate wiring and the service charges for the communications connection. All of the necessary equipment is available now except the communicating copier (which, as noted above, will initially have a high cost). Its cost will decline, however, so that it will account for less than half of the 1990 equipment cost of the teleconference classroom. The audio and TV costs are expected to decline only slightly from their present level, though increased sophisticiation provided by computer control is likely to be provided.

2. Networks and Central Facilities

All of the user tools described in the preceding section will be connected to communications facilities at least some of the time. This section describes the communication networks and devices which we believe most colleges and universities will wish to employ in the 1990 time frame to provide the necessary services.

2.1. Intra-Building or Department Network

Figure 1 depicts a typical intra-building communication network of 1990. The network has a communications switch at its center, which interconnects the devices in the building with one another and with external lines. These switches will be much like the more advanced ones available today, connecting digital bit streams between input and output ports and multiplexing the streams as necessary. Very roughly, there is likely to be one such communications switch per building, but numerous exceptions are likely. Where a number of smaller buildings are adjacent and can be connected to a single communication switch, there may be one switch for several buildings. Alternatively, a few of the larger buildings with very high activity may require more than one communication switch to serve the multiple user groups within the building. The exact location and number of switches can be determined on a evolutionary basis as user demand grows.

All of the user tools defined above will be connected to the local communication switch (Figure 1 shows only one of each kind, but of course many display telephones and smaller numbers of the other devices will be distributed through the buildings served). The communications switch provides local connections: between a local document station and the communicating copier that serves it as a printer, or between an administrative terminal and the local administrative mini-system it interacts with. Any of these terminals can also be connected through the switch to an external line by appropriate dialing. The communications switch will also serve to connect other kinds of digital devices with external communications as needed. For example, the "general purpose computer" shown in Figure 1 represents any kind of data processing facility which may be located in the building in addition to the administrative and communication devices considered in this report.

Most of the connections between the communications switch and the user tools will be ordinary telephone lines. How-

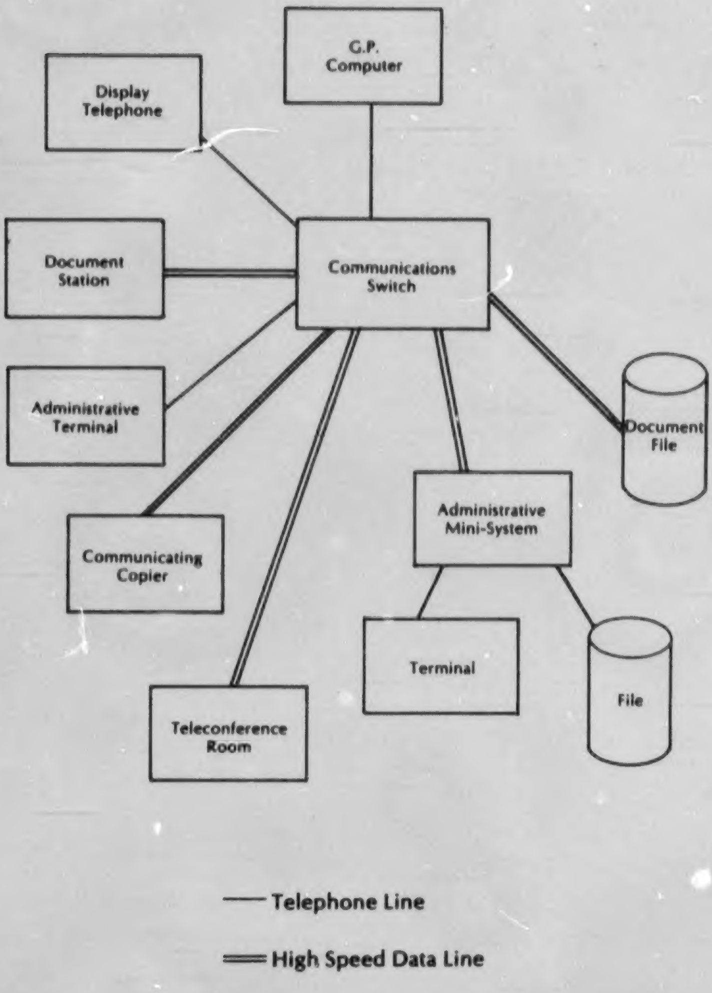

G.P. Computer
Display Telephone
Document Station
Communications Switch
Administrative Terminal
Document File
Administrative Mini-System
Communicating Copier
Terminal
File
Teleconference Room
Telephone Line
High Speed Data Line

FIGURE 1. Intra-Building (or Department) Communications Network

ever, some of the lines will have to handle higher speed data transmissions than is possible over telephone lines. When a communicating copier, for example, is connected to a document station and is required to print a large number of pages of completed text at full speed (2 seconds per page), a connection between the two having a bandwidth of on the order of 48,000 bits per second will be needed; higher bandwidth will be needed for completely graphic information. If the communicating copier is to communicate at full speed with another one located elsewhere, the 48 kilobit (or greater) connection must be made to the external system as well. If the teleconference classroom is to be used for live video communications with a remote point, even higher bandwidth connections need to be provided. Therefore, the communications switch will have to be provided with the ability to handle wideband lines selectively as well as narrowband ones, and the building in which it is located will have to be wired with appropriate cables to those stations requiring wideband capability. (These cables can be standard coaxial ones or perhaps, in a few years, optical fibers.)

Files are shown at two points in Figure 1. The administrative mini-system is shown with a file capability; it will usually store the administrative and financial files of the administrative entity it supports. Communications with these files will be routed automatically through the switch from the local administrative terminals and from the external communication network for transactions originating elsewhere.

A document file is also shown connected to the communications switch. This document file (which would be processed by a small control computer) is envisioned as a means for a department or research center to maintain electronic files of such archival, working and instructional material as justify cost of electronic storage. Such files will vary widely. The user will have several choices: to maintain small document files at the location of the document station (which has about 200 pages of internal storage, plus optional file storage); to store them locally, accessible through the communications switch; or to store them centrally or externally for public access.

2.2. Intra-University Network

Figure 2 depicts the University-wide communication network which we believe will be appropriate by 1990. Each of the boxes labeled "switch" refers to one of the local switches depicted in Figure 1; each will have a building or department complex of user tools connected to it.

As noted above, by 1990, Harvard probably will want to install its own communication switches for most intra-building and intra-department service. For external communications, however (whether they be with other Harvard buildings, or with external locations), the opposite is likely to be true: the University will prefer to make most connections through the Telephone Company's facilities (or perhaps those of competing common carriers). Our survey showed that the pattern of intra-Harvard communications is relatively light and diffuse, except for certain major paths where large volumes of traffic can be expected. Therefore, as Figure 2 shows, the local switches should in most cases be making external connections by means of rapid automatic dialing through the common carrier's facility, rather than through Harvard-owned lines.

To a certain extent, however, high-speed communications of a semi-permanent nature must be provided between certain Harvard locations. These will serve to interlink teleconference classrooms, to connect communicating copiers used for accelerating the distribution of University mail, to exchange of relatively voluminous information between originating points and the University Printing Office and the central document files, and to connect user tools with specialized networks that are most conveniently connected to a single, central point (the present EDUNET is an example). These connections will require wideband cables and a central wideband switch to provide the appropriate interconnections. These will have to be provided by the user, but all other communications are likely to be provided more cost effectively via the common carriers.

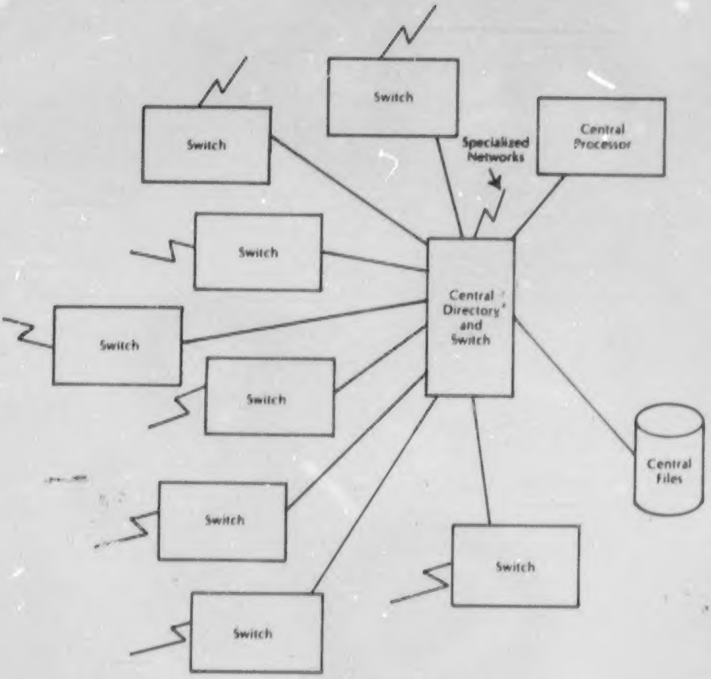

Switch
Switch
Specialized Networks
Central Processor
Switch
Switch
Central Directory and Switch
Switch
Central Files
Switch
Switch
Switch

FIGURE 2. Intra-University Commuinications Network

2.3. Central Facilities

As observed, much of the information storage and processing at Harvard is likely to be done on a decentralized basis by 1990. The detailed administrative information processing for most academic entities is likely to be performed by mini-systems contained within them. The document preparation, storage, filing and local printing for each entity are also likely to be performed locally. However, even within this largely decentralized environment, there are several types of facilities that should probably be provided centrally by the administration.

The University most likely will wish to provide directory services centrally. (These will not require dedicated lines to the local switch; the user may obtain access to them on a dial-up basis.) These will include the appropriate central directory for telephone service (with limited voice recognition as described above) and for data: financial transactions which originate in a location other than that where the administrative mini-system storing the appropriate files exists will have to be routed through the University's central directory to the appropriate point.

- Some central administrative data processing facilities will still be appropriate. Some applications will probably not have been reprogrammed for administrative mini-systems. Users will also prefer to run some applications on a central facility, either because extensive processing resources are required only periodically (e.g., for printing large numbers of personal letters in the Admission process), or because a very small academic entity cannot justify an administrative mini-system of its own. Also some administrative applications (e.g., central payroll) will still be most appropriate on a central basis, so that common procedure and security precautions may be observed. The appropriate transactions will be routed to them for processing by the network. Institutions more centralized than Harvard may have a greater degree of processing centralization.

- It may be appropriate to maintain certain digitized document collections and their indices on a central basis. For example, the libraries may find it appropriate to share expensive equipment required for search, storage and retrieval. This will be particularly true if a need develops for full-text associative searching systems which are likely to be expensive, specialized and fast; it would be logical to serve many users of them on a time-shared basis.
- Despite the trend of recent years toward decentralized research computing in relatively small machines, the growth of graphic image processing or other techniques such as simulation, may require the time-shared use of specialized, very fast processors. If so, it may prove desirable to provide such machines on a central, shared basis.

3. Costs and Benefits

The overall benefit of the "ideal system" would be to improve the effectiveness of people. Secretaries can spend less time answering telephones and re-typing drafts; administrators can spend less time searching for and reconciling data; managers and deans can have better information for planning; faculty members can spend less time in the mechanics of writing, revising or searching for material; and all parties will have more rapid access both to information of many kinds and to other people.

A college or university using the "ideal system" should be able to function as well as it does or better with fewer people. How many fewer people would be needed, of what kind or where cannot be predicted exactly. The eventual products and services do not exist yet, so their effectiveness cannot be measured. During the coming years more knowledge will be accumulating, however, and it may develop that the ideal system can be justified largely on the basis of salary offset. Also, most of the equipment purchase costs would be offset by reduced procurements of conventional devices.

In addition to procurement cost, there will be operational costs for the ideal system, mostly payments to communications carriers. There is no reason to assume that these would be much higher that they are now.

Cost is not the only barrier to installation of the ideal system. Others are:

— Behavior change. The benefits of the ideal system will be realized only if all users of it do more things for themselves: initiate communications, request reports from computers, edit (if not typewrite) papers. Surely a substantial number of the faculty and staff will be reluctant to become system operators; only time will tell how many. Furthermore, the system's capabilities will suggest changes in work and staffing patterns which will (at best) take time to become familiar.

— Staff quality. New skills will be needed to exploit the ideal system fully. Even if it is very easy to use, its very richness of options will pose a challenge. It is not certain that any institution can hire, train and retain adequate numbers of secretarial and administrative staff with suitable skills, even though fewer of them may be needed. On the other hand, jobs involving working with the ideal system may be perceived as more interesting and attractive.

— Compliance with standards. Intercommunication is fundamental to the system's success. This means that all the devices must have standard interfaces to the communication system, and that transaction data moving through the system must be defined in a standard way. Furthermore, users must abide by operational standards (e.g., all financial transactions must be entered by the end of the day, if other users' files are to be current the next morning).

Since the magnitude of these problems cannot be known in advance, it is prudent to proceed gradually via a series of experiements and pilot projects that accumulate experience at each step. Hopefully, a gradual approach will permit each institution to stay within its budgetary limits and cost-justify each step, while at the same time proceeding in a direction that will eventually realize the promise of future technology.

3

New Technologies for Colleges and Universities

Elizabeth L. Young, Public Service Satellite Consortium

Imagine that due to retirements, resignations and stringent budget conditions your full time Economics Department is reduced to three people. Ironically, this comes at a time when there is a slight increase in both undergraduate and graduate majors. Furthermore, you cannot even find someone to teach part time to cover the course in "Economic Systems in Developing Countries." What to do? Your Department Chairperson in one of his monthly teleconferences with the economics chairpersons at the fourteen other universities in the neighboring states explains the problem. He learns that at University X, such a course is being taught by a tenured faculty member. University X has been "exporting" courses by satellite for several years, and can easily add the "developing countries" course to its "export" catalogue. Your chairperson requests the course, initiates the paper work to reimburse University X, and the students at your university have the choice of taking the course "live" by satellite, with classroom interaction, on tape on a delayed basis, or at home when the course is offered as an interactive program on the cable channel which your university also programs for fourteen hours a day.

Suppose that you, as the Vice President of Public Affairs for your university, want to establish a news bureau service that includes sending audio and video reports about the unversity to broadcasting stations throughout the state. Furthermore, you would like to see and hear what other universities are doing in this regard and occasionally to produce jointly a program about higher education in the state. You initiate a letter to your peers at the other state universities, you arrange a teleconference to exchange information and ideas about such a service, and you get into production. Then, to facilitate timely distribution of the materials, you arrange with the communications center on your campus to "uplink" your audio and video "feeds" to the satellite, meanwhile notifying all the broadcasters and cablecasters in the state when your transmissions may be received and used. Once every three months, you and the other Public Affairs people around the state produce and put together — by satellite — a short documentary about recent developments on your campuses. This program is sent by film, tape and satellite to broadcast stations and cable systems, but it is also pressed on video disc for use by libraries throughout the state. It is a good promotion piece for higher education and it can reach a broader audience if it is not dependent on a single "airing" by a television station.

Impossible or improbable scenarios? A vision for the distant future? Not at all. For we are speaking of technologies — communications satellites, cable, video cassettes, video discs, computers — that are already being used to solve problems and create new possibilities around the globe. Let's take a look at the stage of development of these technologies and see how they might work for us in the world of higher education in the next few years.

Communications satellites have been operating since the early 1960's, but the first commercially owned U.S. communications satellite began operating in 1975. Since that time, capacity has increased significantly so that at present there are more than 100 transponders — or channels — available on our domestic satellites. The INTELSAT birds, which provide world-wide communications, can interface with our domestic satellites, thus providing transmission capability around the globe.

Until very recently, the costs of getting involved in the use of communications satellites were comparatively high. The Federal Communications Commission, which regulates this and other areas of wired/wireless telephony, had set rules about the size of the sending and receiving antennas, and all equipment had to be licensed. There was enough risk and enough uncertainty about the whole idea of satellite communications that the commercial broadcast networks did not commit themselves to the concept. Rather, it was the cable industry and public broadcasting that began using satellites for their networking activities. Now, every public television station has a satellite earth station capable of receiving transmissions from Western Union's WESTAR I. By mid-1980, all the radio stations affiliated with National Public Radio also began receiving programming via satellite. Since the majority of these public broadcasting stations — both radio and TV — are located on college and university campuses, many institutions of higher education are already in the satellite business. Meanwhile, with over 4,000 cable systems operating now in the country, more than half can receive satellite programming and virtually all cable systems will have this capacity within the next two years.

Another very significant event occurred in October 1979. The FCC "deregulated" the rules for ownership of receive-only earth stations. In other words, they said that if anyone — a broadcaster, a college or university, a city or state agency, a business, an individual — wanted to acquire an earth station that would only receive signals from satellites, that could be done without going through any formal licensing procedure at the Commission. No license, no specific equipment specifications — you just get your "dish" antenna. If you want certain types of protection, you have the option of licensing your satellite terminal, and you still need a license if you plan to operate an uplink or transmitting facility. However, the deregulation, the increase in the number of satellites in orbit, the entire move of the communications industry toward uses of satellites in combination with other technologies have vast implications for education and for each of us.

While the satellites are efficient at covering long distances, we still require terrestrial facilities to deliver signals within smaller geographic areas. The technology best adapted to do this in the United States today is cable. First, a few facts. Cable now exists to the extent that it "passes" approximately twenty-two percent of all homes. This does not mean that all such homes are subscribers, but at least we know that cable could reach one-fifth of the population. Penetration is rising, and it is reasonable to expect that it may be up to thirty-five percent by 1985 and up to fifty percent or better by 1990. The biggest change in cable in recent months is that now the major metropolitan areas are being cabled, and the systems being installed are delivering 30 or more channels. Of the more than 4,000 cables systems in existence today, some 60 percent are still capable of delivering only 12 channels of programming. These small systems are being upgraded, or rebuilt, but for the near term future their capacity is limited.

Therefore, the potential of cable is great. Its present ability to deliver varies from market to market. Such sophisticated systems as Warner's QUBE, pioneered in Columbus, Ohio, with the capability of interaction through digital response will not become common for at least five years. But we need to understand what the technology may be able to do in order to plan its uses intelligently for higher education.

In a system such as the QUBE, there will be the potential for two-way response by subscribers on at least some channels. Thus, programming — whether of an entertainment, informational or educational nature — can be interactive. In the courses already developed in Columbus, professors have been able to ask questions of the participating audience and can get an almost instant response via the master computer which tabulates and reports answers. In this way it is possible to get feedback of any informal kind (with questions such as, "Did you understand that last explanation? If so, touch button 1 on your QUBE.") and of a formal kind ("This is a quiz: the question is multiple choice and you should touch the QUBE number corresponding to the correct answer.") The computer records and stores the individual responses so it is possible to have, in effect, a test sheet that is the computer print-out.

Colleges and universities in communities that are being cabled will likely find that they are offered one or more channels to program by the incoming cable company. Even if the concept of how that channel will be used is far from clear, the offer should be accepted. The commodity is a valuable one and a real asset for reaching distant learners and the community in general.

Video cassettes are already well known as a medium of distribution, but the video disc is just coming on the market. It will, however, have major implications for education. While in its simplest form it is just another medium on which "straight ahead" video and audio can be recorded, the disc has the potential to be more. For example, with the more sophisticated disc systems (and there are several unfortunately incompatible systems being developed), one can have "freeze frame" for an unlimited length of time, one can fast forward or reverse to a preselected frame, there can be a limited "memory," and when coupled with even a simple computer, the disc allows for "branching" and interactive response. The disc player when coupled with a microprocessor then blends the best of video/audio reproduction systems with computer teaching techniques.

Some further examples of what discs can do: record two tracks of audio, e.g. for two-language learning, so that one can switch between tracks; combine textual material with video material; serve as an efficient storage medium; serve as a source for broadcast programming (most discs will be capable of being used directly on the air with the aid of a time-base corrector).

The major disadvantage of the video disc is that it is neither simple nor inexpensive to produce. One cannot record on the disc; the pressings has to be accomplished professionally. Only when a volume of discs are required or can reasonably be expected to be marketable does it become efficient to press on disc. Therefore, video tapes/cassettes will still be the medium of choice in many circumstances even though tape is less versatile.

Optical fibers utilizing laser technology are, like satellites, "content neutral" and are not a production or storage medium but a distribution medium. They will replace other, older types of cable and will be more efficient. They will make possible even better and more extensive terrestrial distribution networks. Thus, they can also be considered the counterpart of satellites: the satellite will deliver voice, data, and video traffic over long distances in the air; the optical fiber networks will take those satellite-delivered signals to their final destinations on the ground.

One of the types of services the fiber optic cable may deliver is viewdata or teletext. These are generic names for alpha-numeric services that can be distributed by conventional phone lines or by cable and broadcast stations. In the case of viewdata (the telephone delivered service), you dial a computer, make certain requests, and information appears on your home screen. In the case of teletext, a bank of information (which can include illustrations) is stored and intermittently or continually repeated so that the data appears on your home screen. We are just beginning experiments in this country with viewdata and teletext, but they have obvious implications with regard to the efficiency of information transfer. A college or university could use these systems for everything from textual transmission as a part of a broadcast telecourse to promotion. In the latter case, the university would daily update the computer bank with information about events on campus. That information would, in turn, be rapidly available for interested clients. It is not certain yet in this country which industry or entity will be licensed to provide viewdata and teletext services. But for our purposes, the applications we can envision are limitless regardless of the specifics of licensing and delivery.

We have not even mentioned more conventional media — telephones, broadcast radio and television and print. They will, of course, continue to be available but even their uses will become refined and specialized as other communications technologies come on the scene.

Let's return now to our first two examples of technology at the service of the university. In the first case, where an economics course was to be "imported," the initial contact between your departmental chairperson and his or her peers might be via a satellite teleconference (with audio-only in this case since video would not be strictly required) or via a terrestrial telephone system using a "bridge" mechanism to link all the conference call participants effectively. Once the initial conference or conferences had taken place, the university providing the course would relay it — by satellite to your campus if that is preferrable, or by satellite plus cable. For example, the course might be fed not directly to campus but to the cable system locally in which your university participates. The course could be fed and offered "live" with or without interaction, or delayed. Or, you might take satellite delivery right on campus, offering the course the first time as it came "live" via the satellite but also taping it for storage and later use in the library. If the course were not perishable in terms of its timeliness, University X might even have pressed it on video disc. You would then simply order a supply of discs for use in the classroom, the library or by individual students in their homes.

In our second example, where you as the Vice President of Public Affairs want to produce, share in the production of, and distribute audio and video materials, you might have a similar preliminary audio teleconference with your counterparts at other state and regional universities, using either a satellite or terrestrial circuits. You might then agree that on a given day of the week, each campus with satellite origination facilities will "uplink" its weekly news clips for all other campuses and broadcast stations to take, tape, and use. You might also agree that once a month you will use the satellite for inter-university production of your documentary on higher education. You would probably involve your own on-campus television producer or the facilities of your associated public broadcasting station for this latter endeavor. Meanwhile, on your local cable system and on the channel your university programs, you not only schedule your promotion/information stories for airing but you build in some feedback questions. For example, after a three-minute feature on the new astronomy research program, you might say, "Those desiring more information about the university's program in physics should press button 1 on the channel selector." The computer will then record who responds, giving you a mailing list. For materials that are less time perishable, you might wish to create a video disc about the university, making this a part of off-campus promotion or even part of a routine mailing to applyling freshmen, transfer and graduate students. On the disc version, you may decide to record the audio track in more than one language or add captions for the hearing impaired.

All of these possibilities may raise in our minds the question: will the traditional college or university as we know it now become obsolete? In my view, not at all. It may change but it will find new form, new functions. The advantage to those who administer will be new tools to work more effectively and efficiently even if there is a tremendous "learning curve" while we get ready to use the appropriate technologies. The advantage to those who teach will be that we will be free from the "underbrush" of imparting mundane facts and can rely on the technologies to do the basic work. Then, the classroom can become the real public square of Socrates where discussion, argument and enlightenment can take place.

In fact, assuming the institution itself will continue, it will have other new roles to play. One is that the college or university can become a community center for information exchange and education. As we have seen, by programming the head-end of a cable system by feeding a data bank for a teletext or viewdata service, by interlinking via satellite with other campuses and institutions, the university can extend its boundaries. This latter goal has been given lip-service but limited implementation, primarily because of barriers that have to do with costs and channels of communication. But the technologies that we are discussing today overcome these barriers. The institution can also serve as a viewing center (for community learning and other programs), as a taping and storing facility (you may, after all, be the only place in town with a satellite earth station), and as an access point for diverse community groups who may use your facilities to produce their own programs and share programs.

It may be that some colleges and universities will have enough programming (courseware or ancillary materials) to begin thinking of themselves as major distributors not just to the surrounding state but to a national constituency. Many colleges and universities in this country have been engaged for years in exchanging tapes and films. Now, with the communications satellites, a more direct and convenient distribution channel exists. Community colleges have been especially active in using the "new media," including public television and satellites. It is likely that in the near future at least a dozen community colleges — in California, Texas, Florida and elsewhere — will be exchanging credit and non-credit courseware with each other by means of satellite.

Similarly, the colleges and universities in Pennsylvania are working together on a new project, Pennaramma, which will link cable systems in each community where courses are being offered. The effect will be a statewide network of cable-distributed educational materials for which learners get credit at participating institutions. The University of Mid-America in Lincoln, Nebraska, and the National University Consortium (coordinated by the University of Maryland in cooperation with the Maryland Public Broadcasting Center) already makes use of television, satellites, print, and other technologies to offer courses. The linking of these technologies is the wave of the future and in a real sense the first wave is cresting right now.

Aside from all the questions about appropriate technology — which is most cost-efficient, which is easiest to use, which will reach the most people, which is most versatile — there are prior questions that *must* be considered before any planning about hardware and software begins.

These questions revolve around goals and expectations. It is necessary to have some philosophy if not business plan in mind before engaging the services of any new technology however attractive. For example, if a concrete goal of your institution is to keep enrollments at least level for the next five years but you see a declining curve of traditional full time undergraduates, you may want to set a goal of reaching X-number of "non-traditional" learners over those five years. Presumably, you would conduct some type of market study (or use data provided by others) to determine who those students might be, what they want, and what delivery system they will be ready to use. Then you can begin to make intelligent decisions about which courses to offer and in what format.

When I was associated with The Ohio State University as Director of the Telecommunications Center there, we contracted for two studies to tell us what the real interest was in the greater metropolitan area in terms of non-traditional learning. From the results of the two studies (which, incidentally, were highly congruent), the university was able to make reasonable decisions about what courses to offer on its own public radio and television stations, as well as what to produce for the then new and very intriguing cable QUBE system.

In any area of the university, not just the academic departments, we must pay attention to goal setting and goal achieving. There is no point in the University News Bureau using satellites to distribute stories if those stories are getting to all the appropriate outlets at present. But maybe you consistently miss telling your story in the big metropolitan markets of your state simply because the programming people at the broadcast stations there feel your material is dated and inappropriate. Some of what you do to rectify this situation may have to do with content, some with distribution. Technology cannot resolve all your problems, but the variety of production and distribution media available may become new tools for you to rethink how you get to where you want to go.

Another question that must be asked is: how ready is my institution for change, for innovation? What must I do to get it ready? We all need a better understanding of the half-science, half-art that is innovation. Innovation, as we know, requires several elements to be successful. There must be a "change agent" — some person or group that acts to bring about the change. There must be a perceived "fit" between the old way of doing things and the new way.

How do we prepare to teach and administer in the new communications and technology environement? One way is by becoming active in those organizations that are on the frontiers in education and media. One of the many roles of an organization like the Public Service Satellite Consortium is to provide information and education to its members. There are also an increasing number of excellent publications — *not* all written by and for communications engineers — that explain the technologies and, more crucially, how they can be used. Finally, the reader may wish to seek out situations in which he can observe special communications events first-hand. Whether through a visit to Warner's QUBE or attending a satellite teleconference, the opportunity will be provided to see applications and talk to the people who are familiar with them.

We who introduce technologies are not just introducing new hardware or new integrated systems. We are introducing change. This is very difficult because we as educators and administrators are being asked to adapt to change ourselves at the very time we must help others who work with us to accept it. We are both immersed in the new technologies and trying to guide others toward rational uses. Nevertheless, this is the challenge and it must be met.

As former FCC Commissioner Nicholas Johnson observed: "All media are educational. The question is, what is the lesson?" If we find the right answer and use these media wisely, the future belongs to education.

ADMINISTRATIVE

4

Technological Support of Planning at Pennsylvania

Jon C. Strauss, University of Pennsylvania

INTRODUCTION

Pennsylvania adopted a decentralized organizational structure, responsibility center management, in 1974 to better integrate academic and administrative planning with financial planning. The basic emphasis is to distribute responsibility for attaining good financial as well as academic performance to the responsibility centers (schools and other organizational units). This decentralized structure attempts to provide incentives to attain the financial performance that is a necessary condition for good instructional, research, and service performance.

The introduction of this novel approach to management created a whole host of new information needs, some anticipated, but more than just evolved. Coincident with the development of information systems to meet these new needs were a number of efforts to automate the planning process through computer-based modeling and simulation. While the enhanced information systems have proven to be of enormous value to the demonstrated success of responsibility center management, the attempts at automated planning have been far less successful, in part because of the decentralized management system itself.

This paper is organized in three sections. First, responsibility center management is defined and some of the more interesting features are described. Second, the information needs of this decentralized management system are reviewed as are some of the information systems and reports developed in response to those needs. Third, some efforts to automate various aspects of planning are reviewed as are several alternative approaches that have developed.

RESPONSIBILITY CENTER MANAGEMENT

Under responsibility center management, each school (center) is given responsibility for balancing expense with income. By properly defining the planning and fiscal responsibilities, independence of action is preserved while simultaneously encouraging, indeed demanding, more effective use of ever scarcer resources.

An important goal of this decentralization of responsibility is to move decision-making to the level where both information and understanding are available. These levels must be structured so that individuals can still perceive, if not completely quantify, the combined effects of decisions and actions on understood, but ill-specified, objectives, and do so in the face of complex and overlapping constraints. This approach, often termed the "profit center" model, has found wide application in a variety of industrial organizations. The formal use of decentralized management in higher education has been quite limited, however.

Income generated through the activities of each school is credited, and direct program expenses are charged, to the school. The indirect expenses which support university overhead — accounting, maintenance, energy, interest, and the cost of the central administration — are attributed to the schools based on the use they make of such central services. Given their likely direct income and their share of the university's central costs, schools are then asked to build budgets in which their total expense (direct plus indirect) does not exceed their total income.

With this as our strategy, we hoped to accomplish two quite separate goals. First, detailed planning for academic programs would occur at the school level where academic needs, values, and benefits could be identified more clearly. Second, the schools would be encouraged to align their aspirations more closely with available resources. In theory each school would exploit every opportunity to increase its income as well as to weigh more carefully the relative merits of its programs. At the same time, once given responsibility for monitoring expense as well as generating income, the schools would learn to operate within a context of accountability rather than evasion. Six years of experience now suggest that while some schools are better at this than others, all schools have demonstrated success at income development, cost control, and even selective reinvestment.

Of primary importance to the success of the Pennsylvania approach is the central distribution of general university income. By retaining unrestricted resources for distribution to the schools, the president and provost can attempt to insure that the objectives of the university as a whole guide the activities of the schools. University priorities are expressed in part through allocations of general income to the schools as a supplement to their earned income.

The difference between direct income and direct plus indirect expense is the net cost of the programs to the University. Because this is the net cost of obtaining desirable academic benefits, the general funds allocations is termed a "subvention." Indeed, responsibility center management holds that the general income of the university — from the direct contribution of the Commonwealth of Pennsylvania, and from the university's general endowments, unrestricted gifts, and annual giving — should be raised precisely to help cover such costs. In distributing this subvention pool, university officers take cognizance of two additional facts. First, for lots of good reasons, the unit costs of education demonstrate much greater variance that the unit prices. Second, some schools have a greater claim on resources external to the university; hence, they have a smaller need for support from general resources.

Figure 1 presents the FY 1981 budget for Pennsylvania summarized at the responsibility center level.

INFORMATION NEEDS AND REPORTS

As responsibility center management was introduced and the schools were held accountable for financial performance, the deans and faculties began to question how performance was computed. Moreover, they were not content to be told after the year was over how they had fared; they demanded timely information on the variables that affect performance and expressed interest in how they might change the controllable factors to improve performance.

These factors affecting income and expense include:

Income	**Expense**
tuition rates	faculty and staff positions
enrollments	salary and benefit increases
gifts	student aid
overhead recoveries	current expense
sales	space related overhead costs

restricted support
(from endowments, grants, and gifts)

While tuition rates were generally known, most of these other factors proved not to be readily available on a dynamic basis from extant information systems which were oriented mainly to classic accounting and payroll functions. The resulting controversy over the lack of management oriented information was embarrassing to say the least, but it taught us a crucial lesson about responsibility center management; i.e., you must know your institution. We had to know our departments, research centers, and administrative and other central services — what they contribute for what they cost; know our faculty and staff — what we pay them and for what purpose; know our students —

FY 1981 UNIVERSITY BUDGET BY CENTER -- 6/3/80
(000 omitted)

	INCOME									EXPENSE						
	Direct		Subvention							Direct		Indirect				
	Unrestricted	Restricted	Financial Aid	Space	Program Special/	Program Regular	Total	Bank Transaction	Total	Unrestricted	Restricted	Non Space	Space	Total	Net	Note
General University:	55,906	--	(3,798)	(9,488)	(9,075)	(31,319)	(53,680)	(268)	1,958	2,108*	--	--	--	2,108	(150)	1
Health Service Centers:																
H.U.P.	1,133	122,169	--	--	--	--	--	--	123,302	--	121,000	1,081	52	122,133	1,169	2
Group Practice	402	37,058	--	14	--	--	14	--	37,474	--	37,058	401	15	37,474	-0-	
Subtotal	1,535	159,227	--	14	--	--	14	--	160,776	--	158,058	1,482	67	159,607	1,169	
Health Affairs Schools:																
Medicine	16,777	51,368	--	1,121	3,183	250	4,554	135	72,834	10,454	51,368	9,780	1,232	72,834	-0-	
Dental Medicine	11,510	4,921	76	508	896	1,712	3,192	32	19,655	10,974	4,921	3,202	558	19,655	-0-	
Veterinary Medicine	9,872	5,825	--	480	4,846	560	5,886	(237)	21,346	12,082	5,825	2,912	527	21,346	-0-	
Nursing	2,463	1,838	51	46	--	200	297	101	4,699	2,141	1,838	669	51	4,699	-0-	
S.A.M.P.	1,023	343	58	48	--	298	404	95	1,865	1,129	343	340	53	1,865	-0-	
Subtotal	41,645	64,295	185	2,203	8,925	3,020	14,333	126	120,399	36,780	64,295	16,903	2,421	120,399	-0-	
Subtotal Health Affairs	43,180	223,522	185	2,217	8,925	3,020	14,347	126	281,175	36,780	222,353	18,385	2,488	280,006	1,169	
Other Schools:																
F.A.S.	37,578	24,106	2,048	2,174	--	7,220	11,442	(55)	73,071	33,811	24,106	12,765	2,389	73,071	-0-	
Wharton	17,402	12,033	710	568	--	345	1,623	146	31,204	13,636	12,033	4,911	624	31,204	-0-	
S.P.U.P.	833	2,670	6	19	--	171	196	(11)	3,688	641	2,670	356	21	3,688	-0-	
Engineering	7,139	6,109	225	508	--	1,502	2,235	17	15,600	6,251	6,109	2,602	538	15,600	-0-	
Education	2,393	1,264	91	84	--	295	470	(14)	4,113	2,174	1,264	583	92	4,113	-0-	
Fine Arts	2,803	774	150	245	--	1,350	1,745	(57)	5,265	3,115	774	1,107	269	5,265	-0-	
Social Work	1,109	816	63	62	--	293	418	12	2,355	1,147	816	324	68	2,355	-0-	
Annenberg School	363	1,803	74	93	--	89	256	12	2,434	76	1,803	452	103	2,434	-0-	
Law	3,698	803	238	306	--	1,300	1,844	92	6,439	4,221	803	1,076	339	6,439	-0-	
Subtotal	73,338	50,458	3,605	4,061	--	12,565	20,231	142	144,169	65,072	50,458	24,176	4,463	144,169	-0-	
Subtotal All Schools	114,983	114,753	3,790	6,264	8,925	15,585	34,564	268	264,568	101,852	114,753	41,079	6,884	264,568	-0-	
Resource Centers:																
Provost Interdisciplinary	379	3,203	8	--	--	1,655	1,663	--	5,245	2,042	3,203	--	--	5,245	-0-	
Annenberg Center	544	153	--	--	--	316	316	--	1,013	860	153	--	--	1,013	-0-	
D.I.A.	688	510	--	--	--	1,928	1,928	--	3,126	2,616	510	--	--	3,126	-0-	
Museum	749	1,620	--	--	150	866	1,016	--	3,385	1,765	1,620	--	--	3,385	-0-	
Library	1,608	1,109	--	--	--	5,242	5,242	--	7,959	6,850	1,109	--	--	7,959	-0-	
Resource Indirect Costs	--	--	--	1,695	--	5,777	7,472	--	7,472	--	--	5,610	1,862	7,472	-0-	
Subtotal	3,968	6,595	8	1,695	150	15,784	17,637	--	28,200	14,133	6,595	5,610	1,862	28,200	-0-	
Auxiliary Enterprises:	25,950	2,214	--	1,515	--	100	1,615	--	29,779	25,281	2,214	429	1,665	29,589	190	
Administrative Service Centers:																
Student Services	6,652	809	--	--	--	(150)	(150)	--	7,311	6,502	809	--	--	7,311	-0-	
Operations and Maintenance	--	10	--	--	--	--	--	--	10	22,567	10	(22,647)	--	(70)	80	
General Administration	515	833	--	--	--	--	--	--	1,348	10,608	833	(10,193)	--	1,248	100	
General Expense	295	602	--	--	--	--	--	--	897	16,085	602	(15,760)	--	927	(30)	
Space	--	--	--	--	--	--	--	--	--	10,478	--	--	(10,478)°	--	-0-	
Subtotal	7,462	2,254	--	--	--	(150)	(150)	--	9,566	66,240	2,254	(48,600)	(10,478)	9,416	150	
TOTAL	209,804	285,043	-0-	-0-	-0-	-0-	-0-	-0-	494,847	209,614	283,874	-0-	-0-	493,488	1,359	

*$1,000,000 for University Fellowship Program, $250,000 for Provost Reinvestment Fund, $456,000 Salary Contingency Fund, $402,000 Special Emergency Fund.
°Includes $900,000 for Deferred Maintenance and $490,000 for Handicapped Renovation.
/Program Special Subvention is the Special State Appropriation plus an internal capitation amount of $235,000 for Medicine, $296,000 for Dental, and $74,000 for Veterinary.

1. Subventions exceed Resources by $150,000.
2. HUP is planning a $1,169,000 surplus (as expressed in University Fund Accounting).

Figure 1

where they come from and what courses they take; and know our campus — who uses which space and equipment for what and with what use of energy. We found that the success of responsibility center management depends in large measure on timely information and the means to monitor each center's patterns of activity.

The pressure for more and better information was to have far-reaching effects. Not only did it improve the data we brought to bear on decision-making, it forced the university to build better mechanisms of administrative control. Out of this early struggle to make responsibility center management work emerged both the information base and the attendant analytic tools upon which the system now depends.

It quickly became clear that the deans needed better estimates of the impact of their decisions on the income performance of their school. They also wanted some of their income and expenses stabilized or even guaranteed so that they would not have to be responsible for short-term fluctuations. Finally, the deans asked for the tools necessary for them to manage their units, to become responsible in the way we all intended.

Income and Expense Reporting. Our first task was to extract from the accounting system a monthly report aggregating patterns of income and expense across accounts by type at both the school and department level. As with most of our reports, we pursued several goals. First, we wanted to show the aggregate resources available. For too long universities like Pennsylvania had accepted an accounting schema which divided accounts into two categories: unrestricted, often known as the "deficit budget,"and restricted, established for specific purposes. In theory, restricted monies can be used only for the stated purposes. In reality, as almost every good department chairman knows, restricted accounts offer considerable latitude. Indeed in most universities, departmental managers deliberately exhaust their unrestricted monies (seen as coming from the university at large and disappearing with the close of a fiscal year) in order to retain any savings or income windfalls in their restricted accounts (which carry forward from year to year). By portraying all of the resources available to a department, we hoped to make more visible the tradeoff between restricted and unrestricted activity. Indeed, we hoped that once the volume of restricted activity was perceived in the aggregate, good managers would begin testing the generalized limits of their restricted accounts and thus find ways of supplementing their unrestricted income.

Our second goal was to demonstrate that departments were responsible for restricted overdrafts in much the same way that they were responsible for unrestricted deficits.

Finally, income-expense reporting was designed to provide, particularly for the deans, some early warning of pending overdrafts and income shortfalls.

Figure 2 is an example of a monthly operating report in the income-expense format for a sample school.

Census. Having established an accurate reporting system for aggregated income and expense, we turned next to the problem of a university census. One of the unfortunate facts of university management is that very few institutions of higher education really know who works for them; a myriad of contracts, schools, and special relationships, along with a host of external agencies, make it difficult to keep track. Moreover, in many institutions it is often to the advantage of the individual faculty member to obscure as far as possible the sources of his/her income. What is known is his/her academic base salary which tenure guarantees. The academic base can be augmented by administrative stipends, evening school courses, summer courses, summer grants, honoraria, and a variety of consultantships and grant opportunities, all of which can be lost in the maze of often archaic personnel practices.

The decentralization of fiscal responsibility made it of paramount importance that schools and departments know who was paying their faculty (and related staff), how much, and for what purposes. In this way, some of the gamesmanship which previously had hindered central oversight and control evaporated. Ironically, such gamesmanship was replaced with increased demands from the schools that the central administration put its personnel system in order.

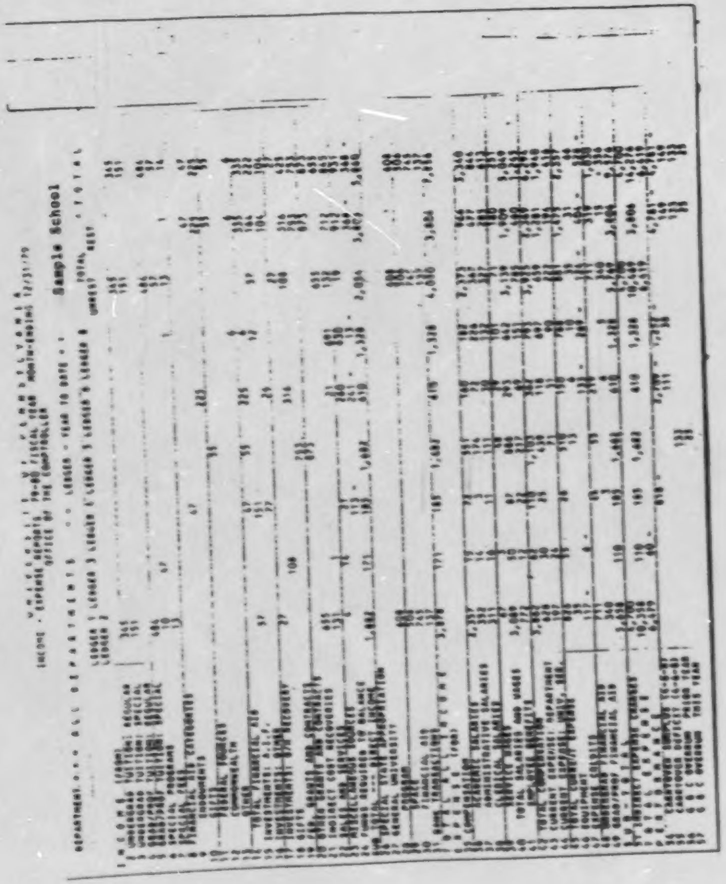


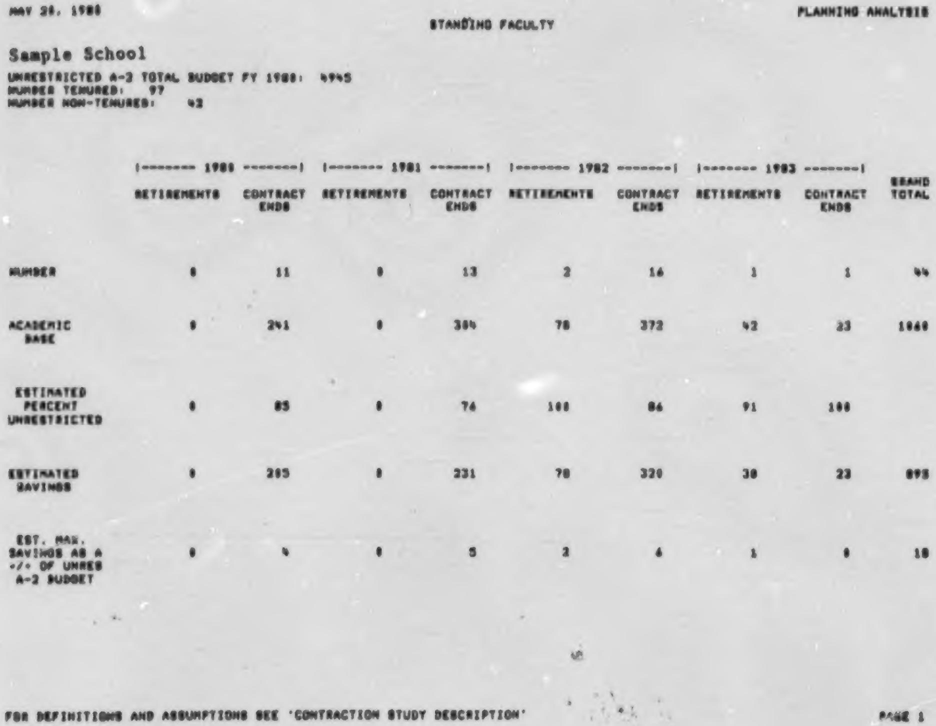
Figure 2

The basic census is relatively straightforward. Describing all university members according to a faculty/staff dichotomy, the census further classifies the faculty into three categories: standing faculty (possessing or eligible for tenure), associated faculty (largely dominated by the clinical research and visiting professors) and the support staff (teaching assistants, research fellows, and research assistants). Importantly, the census measures the degree of overlap — the number of faculty who hold secondary appointments, particularly those with administrative stipends.

As adjuncts to the census, we developed two supplemental reports. The first shows the pattern of payment to each individual by source (summer teaching, administration, and so on) for every member of the university staff. The second, combining the records of the personnel system with the registrar's office, reports on the teaching activity of every individual faculty member, first in directory format and then in aggregate categories based on departmental affiliation and rank. Figure 3 is an example of a report drawn from the census data base.

Course Enrollment. An early decision to distribute tuition income (and student aid expense) based on course enrollments exposed another information need. For each course and then each sponsoring school, the distribution of course registrations by the home schools of the students was needed, early in the semester and then dynamically, to compute tuition income distributions for the monthly reports.

Space and Equipment Inventory. Since we planned to charge schools and centers for their use of space as well as the space related costs for energy, maintenance, etc., we found early on that we needed a much better inventory of the use of space and equipment than had been provided to satisfy previous management practices or federal reporting requirements. A detailed inventory and a new information system were completed just in time to satisfy the new data requirements for equipment sharing and depreciation and space usage under OMB Circular A-21.



MAY 20, 1980

STANDING FACULTY

PLANNING ANALYSIS

Sample School

UNRESTRICTED A-2 TOTAL BUDGET FY 1980: 4945
NUMBER TENURED: 97
NUMBER NON-TENURED: 42

	1980		1981		1982		1983		
	RETIREMENTS	CONTRACT ENDS	RETIREMENTS	CONTRACT ENDS	RETIREMENTS	CONTRACT ENDS	RETIREMENTS	CONTRACT ENDS	GRAND TOTAL
NUMBER	0	11	0	13	2	16	1	1	44
ACADEMIC BASE	0	241	0	304	78	372	42	23	1060
ESTIMATED PERCENT UNRESTRICTED	0	85	0	76	100	86	91	100	
ESTIMATED SAVINGS	0	205	0	231	78	320	38	23	895
EST. MAX. SAVINGS AS A +/+ OF UNRES A-2 BUDGET	0	4	0	5	2	6	1	0	18

FOR DEFINITIONS AND ASSUMPTIONS SEE 'CONTRACTION STUDY DESCRIPTION'

PAGE 1

Figure 3

These basic reports — income-expense, the census (including faculty teaching analysis and sources of payment), course enrollment, and space and equipment inventory — provide the basic information with which the central administration performs its oversight function under responsibility center management. More importantly, these reports provide the information that the schools require to manage and plan their own resources.

AUTOMATED PLANNING

Our efforts to develop planning support of responsibility center management have focused primarily at the school level with total university planning then being the aggregate. A significant exception has been in our annual tradeoff study of three major planning variables: tuition income, faculty and staff compensation, and program improvement.

Figure 4a illustrates our model for projecting income and expense as a function of several important independent variables. Figure 4b shows some sample results. Here, the success lies in the simplicity made possible by good information and careful characterization of income and expense items. This model demonstrates superbly, in a readily understandable way, the inevitable tradeoff between these key variables in the Pennsylvania budget.

Technology makes possible the gathering of the information and the portrayal of model results, as in Figure 4b. The primary value of this model however arises from the fact that it need not be implemented by a complicated computer program and thereby suffer the suspicions associated with "black box" magic.

Early in the development of responsibility center management, we focused significant energy on developing computer based planning models to support the annual budgeting and five year academic planning processes. While those computer models are still used by some, most schools have moved to simple manual projection models.

Figure 4a
FY 1982 Preliminary Budget Projections
Use FY 1981 Budget Figure 1 as Base

$$\text{Expense} = (118.5 + .5 - 2.1)\,(1 + S) + (13.9 + 2.1 + 1.0)\,(1 + T) + 41\,(1.1) + 21.7\,(1.05) + 14.5\,(1 + \mu)$$

$$1 + E = \frac{\textit{Expense}}{209.6}$$

$$\text{Income} = (105.9)\,(1 + T) + (74.1)\,(1 + E) + (29.8)\,(1 + \alpha E)$$

Where:

T = fractional increase in tuition income
S = fractional increase in salaries and wages
μ = fractional increase in utilities costs
E = fractional increase in projected expense
α = relative improvement in uncontrolled income

Notes: Base benefits costs will increase by $500,000 independent of salaries. Base financial aid improvement of $500,000 for University Fellowships. There will be a shift of $2,100,000 in Graduate Assistant tuition remission from the benefits pool; $500,000 subsidy for restricted Graduate Assistant tuition.

Figure 4b
FY 1982 Projected Variance
(Million $/Percent of Program Improvement)

Average Tuition Increase	Average Compensation Increase		
	.09	**.11**	**.13**
.11	(2.8) (2.3%)	(4.4) (3.5%)	(5.8) (4.6%)
.13	(.9) (.7%)	(2.4) (1.9%)	(4.0) (3.1%)
.15	1.0 .8%	(.5) (.4%)	(2.0) (1.6%)

$\alpha = 0$
$\mu = .25$

Average Tuition Increase	.09	.11	.13
.11	(4.1) (3.3%)	(5.7) (4.5%)	(7.3) (5.7%)
.13	(2.4) (1.9%)	(4.0) (3.1%)	(5.6) (4.3%)
.15	(.6) (.5%)	(2.2) (1.7%)	(3.8) (2.9%)

$\alpha = 0$
$\mu = .4$

In sum, we have found it to be most important to get the right information to do good planning. Interestingly, it appears that our decentralized management structure itself, obviates the need for complicated planning models by structuring the environment and the decisions into perceivable units.

CONCLUSIONS

By most measures, responsibility center management has enjoyed real success at Pennsylvania; from the financial perspective, not only has the budget been balanced since 1975, but sufficient operating surpluses have been developed to repay completely more than $7.5 million in accumulated deficit. From the academic perspective, Pennsylvania has never been better recognized for the quality of its undergraduate education and the extraordinary breath and depth of its graduate and professional programs. Obviously, good management is more important than a good management system to this kind of performance record, but there is little question that the fresh viewpoint, the exquisite information, and the performance incentives of responsibility center management have helped to make this performance possible.

When this success is placed in the context of use of technology and automated planning, it is abundantly clear that it has been the new information systems which have played a pivotal role. While there have been numerous attempts and some isolated successes in automating planning at Pennsylvania, the contribution of these efforts pales in comparison to that of the information systems.

Probably the primary reason for this distinct lack of success of automated planning at Pennsylvania is captured in the description of the objectives of responsiblity center management in the first section of this paper. Namely, our decentralized organization was designed to organize decision-making in a hierarchy which, while it requires information tailored to the needs of each level, so simplifies and stratifies the interactions that automated planning models have not proven to be as useful as the have at peer institutions with more conventional centralized management.

5

What Decisions Can Be Better Made Using Technology?

Howard S. Lyon, Purdue University

Among the many problems facing higher education today are declining number of eighteen year olds, rapid inflation, high percentage of tenured faculty, deterioration of facilities, increased accountability and decreased funding. Conferences are held, papers are written, cost studies are completed, models are developed, agencies are created — all designed to try to discover insights or solutions to these problems. None of these activities, however, can create more 18 year olds or reduce inflation. In fact they all consume rather than generate dollars. The question remains — what can be done?

As someone once said, "Today's problems are the results of the unanticipated consequences of yesterday's decisions." Many of the problems facing higher education are direct results of such unanticipated consequences. During the years enrollments were increasing, residence halls, classrooms, laboratories, — in fact whole campuses — were built and new faculty were hired and granted tenure because most assumed that increases would continue forever, or at worst level off. Few looked much further ahead than the period of time necessary to complete the facilities. Perhaps the worst unanticipated consequences of these decisions is the current demand for increased accountability. This has led to all types of new agencies and associations making pronouncements about the way to manage; the magic solutions brought about by cost studies; the best way to plan; line item budgets, etc. In fact we have educated a whole new generation of Higher Education administrators. They have no experience, but they have all the answers and are very prolific in writing about them.

The best that can result from all the time, energy and funds spent on these activities is to try to provide better information about the consequences of decisions which are made today. This leads us to the topic of this paper. "What Decisions Can Be Better Made Using Technology?" The immediate answer is probably not many — particularly in public supported institutions. Political decisions to close campuses, reduce absolute funding levels or eliminate total programs may happen, but not in any regular or rational sense. Legislatures will try to force administrations to make their decisions and administrators will try to blame legislatures. The result will be knee-jerk activities that accomplish little. The best that university administrators can do is to try and smooth the process to some point of equilibrium while still providing quality education, research, and public service programs. Perhaps in ten years we will know if the increased use of technology helped make the results of today's decisions any better!

There are several areas which lend themselves to technological applications which can help our planning and decision making process. All of these, though, are only as good as the assumptions which are made and the relationship among the variables defined. Further, most of these planning aids would be possible without complicated technology; they are just simpler using computers and related software packages.

Let me cite some real examples which I have been involved with at Purdue. Several years ago, it became fairly obvious that the bloom was off higher education, and that the best we could expect from the Indiana taxpayers would be a funding level that would keep pace with inflation (an assumption which now appears to be a dream). Some felt that this was not a serious problem; we would simply increase our private fund raising to give us the additional revenues needed to improve the existing levels of operation. Others, however, felt that this was unrealistic. At that time we did not have access to any useful modeling package, but we did have calculators, and people who could add, subtract, multiply and divide. It took about a week, but using the modest assumption of 7% inflation with corresponding increases in fees and state appropriations, it was demonstrated that income from private sources would have to increase in excess of 500% to provide the needed resources. We went back to the drawing board, both in terms of our planning and in our method of doing such projections. We turned to the EDUCOM Financial Planning Model (EFPM) to assist us in making projections. The model allows us, almost within minutes, to predict how much fees, state appropriations, gift income, etc., would have to increase to support various expenditure levels and/or individual assumptions. Further we can determine the individual fee schedules required to generate the identified revenue. Using the model has helped our decision making process, but I would stress that its predictions are only as good as the assumptions made about such things as total enrollment and the split between resident and non-resident students, inflation rates, etc. Perhaps the most important aspect of this project was the identification of the magnitude of the potential funding problem which lead us to a more careful examination of future expenditures and revenue sources.

While no one can guarantee the results or accuracy of the assumptions used, we have some other technological tools which help in areas like enrollment projections. As do most universities, we know how many students we have had historically, where they came from, in what programs they were enrolled, how many 18 year olds there were in the counties, state, and/or nation, etc. All of this information is in the computer which allows us to develop some historical correlations which can be used to project the future. What we don't know is what academic programs will be sexy 10 years from now, what changes may occur in the percent of 18 year olds going on to higher education, what various financial assistance packages will be available, and so on. However with the use of various assumptions, we are more confident of the parameters within which the future may operate and the extremes of the consequences of our decisions.

Our experience with these applications using EFPM led us into the development of several techniques and applications. Some are ahead of their time, while others have been quickly adopted and ingrained in our routine processes. None of them require any sophisticated understanding of statistics, high level mathmatics or computer science by the people for whom they are developed.

The most basic models we have developed using EFPM are ones to calculate anticipated income from student fees, and to develop equilibrium budgets in several of the self-supporting activities. Another technological application, while not a model, is experimentation with a paperless budget process which at Purdue is decentralized and entails entering individual salaries, supply and other expenditure amounts at the departmental level. Historically this has been typed, key punched, entered into the computer for various audit checks, then re-entered to correct human errors until finally everything is in balance. Our new approach is to enter all information via terminal with immediate audits. Once in balance, accounting and payroll information is automatically generated and budget analysis as required by various managment levels is provided. The result of this process is not necessarily better, but it certainly reduces the amount of time and manpower required for the budget process resulting in some dollar savings.

In the academic areas, we provide analysis and projections of cost per credit and contact hour which reflect both historical and projected enrollments, and various funding levels. The analyses are done by school, department and university level at periodic points throughout the year and enable administrators to test their decisions regarding allocation of funds and the like both before and after the fact.

We have developed a faculty projection model which reflects current staffing patterns and anticipated enrollments, turnover rates, and retirements, all by department, school and total university. This is by far the most sophisticated model we have constructed and to this point has met with the most limited acceptance — probably because there are too many assumptions involved at too detailed a level. Its complexity makes the relationship difficult to comprehend and thus the results predicted difficult to explain. Of course this model also deals with human lives which always create concern.

Our most recent application of technology to the management process is the modeling of our total equipment inventory. For many years we have had an equipment inventory which listed individual pieces of equipment as they were purchased, how much they cost, and the source of funds used to purchase them; yet nothing was done with this information. We now have a complete inventory, which can be summarized by type of equipment, age, fund source, etc., at today's cost. This information is being used to support our legislative requests, and to identify critical funding needs internally based on age and replacement value of the equipment currently available in various academic units. In other words it is a tool to assist the administration in establishing priorities for additional funds which may become available.

There are numerous other ways that technology is applied at Purdue. For use by both the financial and academic arms of the university, we have developed a model to assist in determining indirect cost rates to be charged to sponsored research grants and contracts under the new federal regulations (A-21). Our Personnel Services staff is using technology based tools such as EFPM, SPSS and a data base language (RAMIS) to support completion of wage surveys, to determine wage lines, and to model the local wage market and project Purdue's competitive position given varying assumptions about salary rates within the market. Teaching, salary and financial information exchanged with AAU institutions is being analyzed so that it can serve as input to the planning and decision making processes within the academic/administrative environment of the university. This information also is used to support our legislative budget request. We have adopted NCHEM's Induced Course Load Matrix which records where various student majors take courses, so we can better predict where resource requirements will change as enrollments shift, or what the impact of funding changes might be. We are also one of the few institutions that schedules students into classes and classes into rooms by computers.

Working with these various planning tools has convinced me that there are several ingredients necessary for successful implementation. First and foremost is a management team that understands the modelling process and is not intimidated by models. Decision makers must not assume that models will make their decisions, nor should they feel the models are taking their management prerogative away from them. They must understand that models, as well as some historical analyses, are only as good as the assumption made while defining the mathematical correlations, and only describe what might happen if all assumptions result. This is one reason I support the practice of multiple assumptions. By making numerous assumptions a manager better understands that there are varying degrees of accuracy and that ultimately decision must be made by him or her.

Related to this, is a second important ingredient; neither the people running the model, nor the physical constraints of the model should describe what the decision maker needs to know. The decision maker should make clear what information he needs and the model builder should work with him/her to help clarify the necessary assumptions. This is important for two reasons. First it helps the model builder understand what is desired, and second it underscores the idea that a model is a decision maker's tool, not just a machine belonammers. The best, most accurate information or model in the world will not be used if the decision maker isn't interested or feels threatened.

In order to have an effective modeling process, there must be a management structure and support; machines, software and people, that have equal strengths and abilities. Software without machines or skilled people won't work and vice versa. Communications links are extremely important, but will vary depending on the size of your institution, and/or who the model is being developed for or by.

Two other ingredients for successful modeling are an accurate data base and the capability to accomplish individual projects with relative ease and minimum expense. One of the most frustrating responses to a person wanting to use technological input is "yes we can do it, but it will take 100 hours of programming, cost $15,000 and maybe we can have it done a year from next Tuesday." Many managers will conclude — probably correctly — that it's just not worth it. Both the novice and the experienced user of models may well want to experiment a bit, so if the mechanics are expensive, inflexible, and take a long time they will soon turn to something else.

Various forms of computer technology can be very helpful in assisting university administrators anticipate the future results of current decisions. But such assistance can only be accomplished if the management structure from top to bottom (the decision maker to the modeler) understands the use, assumptions, and limits of the information provided. No technological tool can or should make decisions, but should serve instead as one of many subjective and objective tools that managers use to inform their decision making process. Good tools do not make good managers, but they can assist a good manager in making better decisions.

6

EFPM: A Two-Year Progress Report

Daniel A. Updegrove, EDUCOM

Many people seem to consider themselves well-informed if they can associate the relevant words with the latest acronyms. In the case of EFPM, however, the words "EDUCOM Financial Planning Model" are (unfortunately) quite misleading. Although designed, developed, and disseminated by EDUCOM, EFPM is *not* limited to financial affairs, *not* limited to planning, and is *not* a model.

EFPM is a generalized computer-based modeling system. Unlike a model, EFPM provides no predetermined input categories, output reports, or equations; instead, it provides a flexible format within which a set of inputs, outputs, and equations can be defined as needed. Thus each user can custom-build a model in keeping with specific policy problems, management structure, and available data. Most EFPM applications are, in fact, financial planning, but there are non-financial and non-planning uses as well.

In technical terms, EFPM is a conversational program available for remote access on the Cornell University IBM 370/168 computer in Ithaca, New York. EFPM users (and the EFPM staff) access the system via terminals connected by telephone to a national data network (rather than by long distance calls to Ithaca), using the facilitating services of EDUNET. Each user maintains a password-protected account on the Cornell computer for model operation and storage.

What distinguishes EFPM from other interactive modeling systems? First, EFPM is based on research, development, and testing in college and university settings, notably at Stanford University. Second, EFPM is significantly less expensive than most commercial systems, both because of generous grant support from the Lilly Endowment, and because users have the benefit of educational rates on the Cornell University IBM computer. Third, EFPM is the first such system to enjoy wide application among colleges and universities, such that its 95 subscribers constitute a wide base of experience and information.

The Origins of EFPM

In the midst of generally unsuccessful modeling applications in higher education, the TRADES Model developed at Stanford University in the mid 70's by William F. Massy, David S.P. Hopkins, and Nathan Dickmeyer, was a notable success.[1] TRADES is an interactive forecasting model with the capability to make feasibility searches and tradeoffs among planning variables subject to user-defined constraints. TRADES grew out of two earlier models of Stanford, a long-range financial forecasting model (LRFF) and a transition to financial equilibrium model (TRANS).[2]

But could the Stanford models be used in other settings? Joe B. Wyatt, then at Harvard, answered in the affirmative on the basis of successful experience with LRFF models built for the Harvard Faculty of Arts and Sciences and the Graduate School of Education. Later, as President of EDUCOM, Wyatt proposed to the Lilly Endowment, also the supporter of the Stanford modeling project, that a more formal experiment be undertaken. Lilly agreed in 1976 to support a two-year study in which the Stanford models would be tested at the University of Pennsylvania, Lehigh, Oberlin, SUNY at Albany, and other units at Harvard.

The results of the EDUCOM feasibility study were mixed. In all five institutions, a model was found to be useful, but, as is often the case with models, success seemed to depend as much on the organizations setting as on the content of the model. In addition, the Stanford models had to be reprogrammed to produce an accurate representation of each institution. Thus, the study concluded that a generalized modeling system should be built employing the Stanford concepts of interactive forecasting and tradeoff analysis, but without the Stanford content.[3]

EFPM Today

With a follow-on grant from the Lilly Endowment in 1978, EDUCOM has built such a modeling system, now known as EFPM. The system is based on four design principles. First, users start with a blank matrix of 560 (variables) by 12 (usually time periods), with no category labels, base year values, or relationships assumed. Second, users specify the content of their models in a series of tables — labels, values, intra-year calculations, inter-year calculations, and report formats — rather than in program subroutines. Third, users build and operate models through a question and answer dialog; that is, the entire process is under the control of EFPM software, with no need for users to learn a system text editor. Finally, users access EFPM via the national dial-in network facilitated by EDUNET.[4]

EFPM's success as a generalized modeling system can be measured in several dimensions. As shown in Figure 1, subscribers include public and private research universities, comprehensive universities, small colleges, seminaries, and others. As shown in Figure 2, applications include central administration and sub-unit budget planning, cash flow management, state funding formula analysis, student enrollment planning, and faculty tenure studies. Finally as shown in Figure 3, the hands-on users of EFPM include policy-makers as well as analysts, many of whom have no previous computer experience.[5]

Network access has been the key to the rapid dissemination of EFPM. Not only does it allow any institution to use EFPM independent of its particular type of computing facility (or lack thereof), it also allows EDUCOM's small professional staff to

Figure 1 EFPM Subscribers

University of Alabama in Birmingham
American Council on Education
American University
Biola College
Boston University
Bradley University
Brandeis University
Brown University
Bryant College
Butler University
California State University — Long Beach
Carnegie-Mellon University
Centre College of Kentucky
University of Chicago
The Claremont Colleges
Colgate University
Columbia University
Concordia College
Cornell University
Cuyahoga Community College
University of Dayton
DePauw University
Duke University
Eastern New Mexico University
Eckerd College
Franklin College of Indiana
Freed-Hardeman College
Fuller Theological Seminary
Georgetown University
Grinnell College
Hamilton College
Hampshire College
Harvard University
Haverford College
Lehigh University
University of Louisville
Louisville Presbyterian Theological Seminary
Universite Catholique de Louvain (Belgium)
University of Maryland
Marymount Manhattan College
Memphis State University
Michigan State University
Mills College
Milwaukee School of Engineering
University of Minnesota
Mount Holyoke College
Mount St. Mary's Seminary of the West
University of Nevada-Reno
University of New Hampshire
New Hampshire College
The College of New Rochelle
New York Public Library
New York University
North Carolina Central University
Northern Michigan University
Oberlin College
Olivet Nazarene College
Oregon State University
Ottawa University
Pennsylvania State University
Pepperdine University
Purdue University
Princeton University
Rensselaer Polytechnic Institute
University of Rochester
Rochester Institute of Technology
Rollins College
The College of Saint Catherine
Saint Meinrad School of Theology
San Jose State University
Smith College
Southern Baptist Theological Seminary
University of Southern California
Stanford University
Swarthmore College
University of Texas Health Science Center
Texas Christian University
University of Tennessee — Knoxville
Trevecca Nazarene College
Tufts University
Union College
United Theological Seminary
University of Utah
Valparaiso University
University of Virginia
Wellesley College
Wesleyan University
West Virginia Wesleyan
Western Michigan University
Wheaton College
Williams College
University of Wisconsin — Madison
University of Wisconsin — Whitewater
The College of Wooster
Yale University
Yeshiva University

Figure 2

Representative EFPM Applications

Central Administration Budget Planning
Central Administration Long-range Financial Planning
Central Administration Cash Flow Management
State Funding Formula Analysis
Sub-Unit Budget and Financial Planning:

Athletics
Buildings and Grounds
Central Services
Computer Center
Dining
Hospital
Housing
Law School
Library
Medical School
Student Financial Aid

Faculty Age and Tenure Studies
Student Enrollment Planning

* * * * * * *

Figure 3

Representative EFPM Users

Budget Director
Assistant Budget Director
Director of Business Affairs
Business Manager
Budget Analyst
Coordinator of Financial Systems
Treasurer
Comptroller
Provost
Vice President for Administration
Vice President for Academic Affairs
Assistant Dean of Faculty
Director of Institutional Research
Special Projects Director
Director of Computer Center

focus on user training and problem solving, rather than on technical conversions and systems support. In addition, the network facilitates remote diagnosis of user problems and inter-user communication.[6]

The EFPM users group, actively supported by EDUCOM, provides a vehicle through which users share models, submodels, data, and experiences via on-line messages, electronic mail, Cornell's remote output mailing service, a monthly newsletter, and occasional meetings. Recent examples of this sharing include the exchange of faculty tenure and student financial aid models, and a one and a half day workshop attended by users at small colleges. It has been suggested that EFPM and its users group could become an online laboratory for comparative financial analysis, but little progress has been made in this area to date.[7]

Costs for use of EFPM break down as follows: an annual membership fee of $1,750 ($1,500 for EDUNET members); a first-year consulting fee of $2,250 ($2,000 for EDUCOM members); travel expenses associated with the consulting and computer and network charges of $5-15 per connect hour (averaging $750-1,000 per year). EFPM can be used with any standard computer terminal.

EFPM New Directions

The major focus of current EFPM research and development activity is financial planning and modeling for theological seminaries. A new grant from the Lilly Endowment provides funding for the delivery of EFPM to eleven seminaries, for specialized software development, and for documentation. It is hoped that successful financial planning in the demonstration seminaries will lead to improved management and planning practice in the wider seminary community, and by extension, in small colleges.

Other new directions include software development to support the inter-model linkage required by disaggregation and reaggregation of subunits; use of system in foreign higher education (EFPM already has a subscriber in Belgium);[8] use outside higher education (the New York Public Library is the first such subscriber); and development of a microcomputer interface related to the EDUNET EASy system.[9] Remote microcomputers linked to a large host computer by network appear to offer the best combination of cost effectiveness and resource sharing, two prominent themes of this — or any — EDUCOM Conference.

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7

Planning Electronic Office Systems In A University Setting

Jon Sandelin, Stanford University

Stanford University is a community of about 20,000 people with a consolidated budget approaching $500 million in 1980. The purpose of the University is to provide instructions to a student body of nearly 12,000 and to conduct research in a wide variety of disciplines. The primary product is knowledge — recorded in its scholarly publications and carried into society by its graduates.

Exchange of information is fundamental to both the creation and dissemination of knowledge, and to the infrastructure (budgeting and funds accounting, admissions processing, people and space administration, etc.) required to support instruction and research. By the time our current transitional systems mature, perhaps before the end of this century, the impact of computer and communications technology on the creation and dissemination of knowledge will be comparable in magnitude to the introduction of the printing press.

This odyssey began about 15-20 years ago in computer science laboratories of major universities when work began on computer programs to help people write, to send messages, to collaborate by sharing access to electronic files, and to store and retrieve information conveniently. The continuing decline in the cost of computer function, and the continuing rise in the cost of labor to perform functions that computers can do better, make the widespread use of this technology inevitable.

In terms of the "three R's" — reading, writing, and arithmetic — a shift is taking place. In the 1960's numerical computation was by far the dominant use of computers. By the mid-1970's, some university computers were used as heavily for writing as for computation. In the 1980's we are entering an era in which, thanks to the evolution of network communications technology, we can expect to READ much information through computers as well. By the 1990's assuming unfettered growth of communications networks, we can expect reading to be the dominant use.

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                                         |_|
1960's       R          R                | \

                       ---              ---
                       |_|              |_|
1970's       R         | \              | \

            ---        ---              ---
            |_|        |_|              |_|
1980's      | \        | \              | \

            -    -
            |    |
            |    |      ---             ---
            | \         |_|             |_|
1990's     _|    \      | \             | \
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In a university setting, the use of computers as a medium for all aspects of written communications — for reading, writing, revising, filing, retrieval, printing, and distribution — is by far the most broadly valuable of the multitude of "office system" applications now beginning to appear.

PIONEERS WITH NO FOLLOWERS

Stanford, paradoxically, is both rich and poor in the availability of computer tools to help people write and communicate. The University is fortunate in that very powerful tools were developed by some groups for their own use several years ago, and many of the people who developed these tools are still in residence. Extensions to their systems programs are under development, and advanced work on computer-assisted document preparation techniques is in progress under the leadership of Professor Donald Knuth in the Computer Science Department.

These tools, however, have been available to only a small segment of the Stanford population (a few hundred people). This is because the funding typically comes from government agencies and is restricted to supporting specific research projects within specific organizations (e.g., the Institute of Mathematical Studies in the Social Sciences, the Artificial Intelligence Laboratory, and the Stanford University Medical Experimental Facility). Access is thus limited to people directly working on those projects. The relatively high productivity of people within these environments and the noticeable lack of clerical personnel (typically 25-40 professionals per clerical worker vs. the university-wide average of about 2 to 1) provided a tempting model for the university as a whole.

In 1978 a small ad hoc group called COST (Committee on Office Systems and Technology) began to consider whether such tools might be extended more broadly at Stanford. COST was unique in that its members came together because of common interest, not executive directive, and they reported to no university unit. Members came from a variety of departments. The process COST followed to develop a comprehensive institution-wide plan, and obtain support for its implementation, is described in detail in the following section.

A FRAMEWORK FOR ACTION

From the beginning, some basic premises provided us with a framework for action. These premises were strongly influenced by our observations of common characteristics at those places where computer tools for writing and communicating were in effective use:

—The availability of a good context (or "full screen") editor.

—The convenient availability of workstations — similar in accessibility to the telephone, i.e., at the place of work, within easy reach, and available also at home if desired.

—Integration of a range of related software modules (e.g., message systems, spelling checkers, filing systems) and hardware components such as printers, phototypesetters, etc. — even if in some cases some "kludging" was needed to create the links.

—A critical mass for effective communications, i.e., almost everyone with whom frequent contact was important was on the system.

Based on these observations, our own experiences, and discussions with many people at Stanford and elsewhere, COST adopted the following premises:

1. Quantity is more important than quality. Given a minimal standard, we felt that widespread use of a basic tool-set of writing and communication tools would do more to further the University's goals than limited availability of very powerful workstations.
2. To achieve widespread use, a system must have a relatively low entry price to encourage experimentation by potential users.

3. The expected useful life of systems should be no greater than 5-6 years. For all practical purposes, communications bandwidth is currently restricted to 9600 bits per second between on-campus locations and 1200 bits per second to homes. Beginning in the mid-eighties, we expect multi-megabit transmission capabilities. Declining costs in processor and storage technology, together with better software for graphics and video applications, will then permit a transition to much more sophisticated systems. But first the transmission capability to make them effective must be in place.
4. Writing and communicating by messages are the broadest applications of computers in the university and are therefore the logical foundation for building an integrated system. By contrast, if many kinds of separately designed, special-purpose terminals were installed, it would be very expensive to make the different systems compatible.

EARLY PREMISES ABANDONED

Two other early premises were subsequently abandoned or modified as additional information was gathered and results analyzed:

1. We thought a single approach would suffice for the Stanford community. Expectation of achieving 100% homogeneity in the university seemed both very unlikely and not even desirable, but we did believe a single system could become the de facto standard among most users. However, as we learned more about the characteristics and organizational dynamics of major communities (e.g. faculty vs. administration) and more about the limitations of what the market had to offer, it became clear that none of the available "solutions" would work well for all. Planning thus had to be adjusted to provide for linking different kinds of systems together so that inter-organization information mobility was not lost. To contain the expense of the work on links, only a small variety of systems could be supported.

2. We felt that system(s) on which much of the university would soon become dependent must be commercially supported. This position was subsequently modified. Although we were well acquainted with the perils and pitfalls associated with locally developed software, we could find no commercial alternative that provided the functions needed by the academic community at a cost that would encourage widespread experimentation. Commercial, turn-key systems were judged adequate for many of the administrative applications. For the faculty and student communities, we adopted a plan that calls for standard off-the-shelf hardware and operating-system software, but that uses locally developed application programs for the text preparation, dissemination, storage, and retrieval functions. These programs had been developed within, and optimized for, the academic environment.

FIRST, A SURVEY . . .

Given these premises, a group of COST members with complementary skills and a common vision set out in early 1978 to see what could be done. In retrospect, what transpired can be partitioned into the following phases:

—The Survey (Where are we now? Who is interested? What systems are in use?)
—The Needs Assessment (What capabilities should be provided both in the near term and several years in the future?)
—The Evaluation of Alternatives (What is available today and what is likely to appear in the foreseeable future?)
—The Development of a Strategy (Where to start, what to do, and how to get it done?)
—Implementation (Turning plans into action. Evaluation and adaptation.)

It is important to understand that these phases do not occur in discrete, serial steps. The process is dynamic — new products that must be evaluated enter the market, needs are not static (and indeed perception of needs changes as consumers become more knowledgeable and begin to experiment with new technologies), people enter and leave the organizations bringing with them (or taking away) notions of what ought to be done, and selling the concepts seems to be a never-ending process.

What follows is a description of these phases as they have evolved at Stanford. They reflect the environment of a major research university — with organizational structure and operating characteristics differing from many other types of organizations.

THE SURVEY PHASE consisted of a telephone canvassing of the many departments of the university to determine who (if anyone) within each department was actively using or evaluating computer-assisted tools (e.g. commercial word-processing equipment or time shared services from central computer resources) for text preparation or communication purposes. The survey was conducted by two people from the Computer Center and one person from a large department, who — at this stage — were interested in the area and concerned that no organized planning was being done nor was there any apparent concern that it should be done.

The information gathered served two useful purposes. First, a data base of existing equipment was compiled. This data base has been continually updated to track the growth in acquisition of text preparation systems. Second, many people who were interested and/or involved in this area were identified. A meeting was held where these people could discuss areas of mutual interest and concern. From that group, a few were seriously interested in better understanding the technology and influencing where it might lead the university. It was these people who formed COST. COST continues to exist today, and its work in teaching others about computer-assisted writing and communication tools and its contributions to university planning have positioned the university to more readily accept the organization changes required to exploit this technology.

THE NEEDS ASSESSMENT PHASE was an important period for us. We were beginning to develop some specific ideas on what we felt was needed. More and more, it seemed to us that the University needed an official coordinator in this area. Word processing salespeople were becoming very active on campus, spreading their own "vision" of what was good for us. In what in hindsight seems a somewhat naive move, we wrote a memo to the University's provost and vice presidents, recommending that a coordinator be appointed. We received a courteous reply that led essentially nowhere. The magnitude of what was at issue had not yet been made clear.

After this slight pause, we regained our momentum by preparing formal documents that permitted widespread review of our emerging ideas within the institution. The reactions and responses generated led to important refinements in our thinking, and also led (eventually) to a general consensus as to what ought to happen among the many people who needed to be involved in implementing new technologies. The end result was a clear written statement of what was needed and a series of questions for potential suppliers, the answers to which allowed us to judge how suitable their systems were for our needs.

One fortuitous event that occurred during this phase was Stanford's creation of a task force to study future use of computer technology by the institution. COST volunteered to provide a planning document on the potential for network-based text systems, thus acquiring the endorsement of a high-level Task Force in its efforts to acquire information and solicit support.

THE EVALUATION OF ALTERNATIVES PHASE involved distributing the needs assessment document to potential suppliers and evaluating the responses. This process not only provided valuable information on what products were available at that time, but also established channels of communication with some vendors so that new product developments could be previewed.

In judging alternatives and developing plans, it became clear that three areas of equal importance needed to be addressed:

—Technical analysis. What are the components of this new technology, who are the potential suppliers, and what are the implications of design differences?

—Financial and economic analysis. What are the economic issues and financial implications of introducing this new technology broadly within Stanford?

—Human and organizational issues. How does, or more importantly how should, this new technology appear to the end user, and what organizational changes must occur for it to support institutional goals effectively? What factors distinguish successful installations from those that fail?

The next phase, THE DEVELOPMENT OF A STRATEGY, began with the issuance of COST's report to the Task Force. The COST report discussed in some depth a range of technical, economic, and humanistic and organizational issues, described various alternatives, and provided recommendations on things to be done. At the time the report was issued, there was no enabling group with assigned resources and accountability to carry recommendations into action. COST was an ad hoc, volunteer group held together by common interest but with no accountability to manage a University program. The newly formed Center for Information Technology, with its broad charter to guide the University in application of all manner of information systems, was a natural home. Thus the Text Network Program was formed as an arm of C.I.T. — to develop an overall strategy, to present specific action plans (with time-lines and resource requirements) to senior management for review and, if approved, to implement them.

In formulating strategy, some elements we had to consider included:

—Territorial and definitional boundaries. The distinctions between telecommunications, reprographics, and computing services functions are blurring. The campus is awakening to the potential impact of direct computer assistance to professionals wherever they choose to work. A "bandwagon" effect is developing that complicates efforts to provide a single focal point for coordinating organization-wide planning. In the broadest context, text preparation and communication "systems" encompass most of the traditional telecommunication, reprographics, computational activities, and thus careful definition of scope is necessary to avoid perceived threat to other parts of the organization. Where organizational entities remain independent of the initiating group, they must be approached as contributors and partners in the planning process, otherwise they are likely to undertake independent planning efforts.

—Managing expectations, both present and future. There is a need to avoid overselling, of committing to what can be accomplished only if everything goes perfectly. Small sure steps are generally more successful, as seen by the end user, that giant leaps that fall short. Our general philosophy has been to partition major projects into two components — a production service which uses only off-the-shelf, proven components, and a research effort which tests, and introduces, on an experimental basis, if warranted, components "in development."

—Avoiding technology-induced paralysis. A very real danger is the lure of the "better" product just over the horizon. There will always be improved products under development, and although careful judgments on timing must always be made, the "better" is the enemy of the "good". A good strategy takes advantage of what is available today, yet provides flexibility to evolve to future product generations — not an easy order to fill.

—Recognizing group differences. Our own experience is that a single approach would not work because of differing needs of the major communities within the University. Faculty members tend to write a good deal, frequently choose to work at home, typically require special character sets in mathematical equation or foreign language composition, and — as a group, tend to have infrequent turnover and are good self-teachers of new ideas. Administrators tend to communicate a good deal via short messages, work mostly in their office, generally require only standard symbols, and, especially among the clerical support work force, experience high turnover rates and are thus more dependent on good training aids (e.g. extensive use of menus). Different approaches were clearly needed, but there is sufficient overlap that links should be supported to permit information flow between the groups.

THE IMPLEMENTATION PHASE is about six months old at this writing. Three major projects are underway under the sponsorship of the Center for Information Technology: commercial word processor support, a project known as "Terminals and Managers," and a project intended to provide writing and communications tools to scholars. The first, commercial word processor support, sprang from a recognition that, stand-alone word processors have inherent limits we hope to grow beyond, the piecemeal acquisitions taking place in numerous departments were amounting in the aggregate to significant expenditures. Any hope of using this equipment in other than stand-alone fashion depended on limiting the proliferation of brands. Such a policy was established, and special efforts have been made to assist the users of the approved brands.

The second project, Terminals for Managers (TFM), is a one-year experiment in which senior officers and their staffs are using a message system. The president of the University himself often turns to his terminal in preference to the telephone. Judging by user acceptance, the project is a huge success.

The TFM project, unlike the scholarly writing project, was conceived and initiated — as an experiment — in only a matter of weeks. That could not have happened without a dedicated staff and access to existing computer capacity. But further, it would not have happened without the enthusiasm of the Director of C.I.T., who as a new user of an earlier message system recognized its potential and was a vigorous lobbyist to enlist his colleagues in the experiment.

Unlike the TFM system, the third project, the scholarly writing system, requires a commitment by the university to make a significant investment in new hardware, and thus has moved less rapidly. We believe the recommendation of enthusiastic colleagues will be just as important with it as with TFM, however, and have accordingly encouraged some long-standing users of similar systems to participate in a faculty advisory committee.

We are at this writing just at the point of selecting initial installation sites for this service. Our hope is to be able to achieve a concentration of users in a few departments rather than have scattered users in separated locations. This is important not only because of the "critical mass" phenomenon in message systems, but because users close to each other are able to help each other during the learning phase. New users are thus less dependent on instant access to system consultants and less vulnerable to the frustration and discouragement of not having help when it is needed. This should promote faster incorporation of the new methods into people's work routines.

In other ways, too, the success of the project hangs in the balance as the initial users are selected. Peter G.W. Keen and Michael S. Scott Morton (Decision Support Systems: An Organizational Perspective, Menlo Park, Addison-Wesley, 1978) have this to say on what they call the "entry" stage:

> "Entry involves ensuring legitimacy for action: defining the problem situation, the nature of a solution, the criteria for evaluation, and the allocation of responsibilities and resources, even if only at a general level. . . Entry requires subtle skills and, in many instances, far more time and effort than any other aspect of implementation. Far too often, analysts respond to the pressure of visible results, and focus on formalizing the system, leaving "people" issues to be sorted out later. However, most of the critical decisions are made at entry. . . Moreover, it is at entry that the client's expectations are set. . . Many failures occur not because a "good" system was not delivered, but because the RIGHT one was not or because the user had excessively high

expectations that led him or her to enthusiastically support the effort but that could never be met in practice."

The word processing industry in the past few years has inundated us with stereotyped images of sophisticated secretaries operating feature-laden typewriters. Sometimes it is quite a job just to erase that image and get people to think beyond it.

8

An Architect for a Text System

Pentti Kanerva, Stanford University

INTRODUCTION

WHAT IS A TEXT SYSTEM?

A text system is a medium for written communication: reading, writing, revising, filing, retrieving, printing, and distributing text. All of these are done increasingly with the computer. We can expect this trend to continue until computers have become our main means of written communication.

The most important hardware components on a text system are processors and memory for the software that makes the system work, terminals (keyboard and display) for people to interact with the system and to manipulate text, file storage devices (disks) for the storage of text in a form usable by the computer, printers for making text available for distribution by traditional means, and communication networks for making text available on line to people at dispersed locations.

The following descriptions give some idea of what it is like to work with text on the computer and of what we have been looking for in our search for a text system for Stanford. Implicit in the descriptions is the software — the computer program — that controls the equipment and the user's interaction with it, and that performs the functions initiated by the user.

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Reading, Writing, and Revising Text. Text is made available for reading, writing, and editing by displaying it on a video monitor. Entering text is like ordinary typing, but revising is much easier, for there is no retyping. Instead, old text can be deleted and new inserted or blocks of text can be copied or moved around as necessary. The commands for these editing operations are simple, and the changed text is immediately visible on the display screen. This makes it easy to maintain a clean, up-to-date working copy of a document. When convenient reading, editing, and filing are provided for, people begin to keep notes, lists, and records in the computer, and these in turn become the source material for later writing. This is particularly true if the system allows the same text to be viewed and modified from different locations — for example, from a terminal at one's office, from another terminal at someone else's office, from a terminal at home.

Filing and Retrieving Text. Filing systems on computers do more than just store documents for later use. They also help keep track of documents providing for the descriptive naming of documents, for the organizing of documents into groups, and for the retrieving of documents by name or by group (i.e., making a document available for reading, revising, copying, printing, sending to another computer, and the like). Ideally, the user deals only with the names of documents, and the system manages the storage.

Filing systems can include other useful information about documents, such as who may read or modify the document, when it was last read or modified and by whom, and what keywords or other descriptions are associated with the document. All such information is available to the user through his or her terminal.

Printing Text. Although some text is intended for use only on the computer, most of it eventually becomes memoranda, letters, proposals, reports, journal articles, books, and the like, and needs to be printed on paper. Computer printing ranges from crude lineprinting to high quality typesetting. Besides controlling the printers, computers are used to prepare documents for printing (formatting, document assembly). It is not uncommon to type a document into a computer just to get it reproduced on paper; most of conventional word processing is merely that, as is typesetting.

Distributing Text. People who share a computer can leave messages (electronic mail) for each other. Messages have become popular because they are delivered immediately; yet the recipient can examine them and respond to them at his or her convenience. The mechanics of responding are simple and a record is left of the exchange. Computer messages therefore combine advantages of the telephone and of the memorandum and complement these traditional methods of communication.

People who share a file system can cooperate in developing ideas. A shared file can serve as a repository for contributions that can be examined and critiqued by the participants. This form of communication is sometimes called a teleconference. Shared file systems also allow the keeping of records that must be seen and updated by people working at different locations.

Messages and documents can be transferred quickly over long distances whenever a computer and a terminal or two computers are connected by digital communications links. Any telephone can be a communication link to a computer, and the telephone system is used increasingly for digital communication.

Computers can be connected in networks that span the country and messages can be sent by people on one computer to people on another. It is very easy for people on such computers to keep in touch with each other and to share in each other's work.

BACKGROUND

This paper discusses three things: on-line storage of text (files, data bases), access to text (communications), and manipulation of text by people (writing and editing). These will be our main concerns as we attempt to make the best use of developing computer technology.

Until recently, the main problem in computing was to provide adequate processing power. This affected the ways in which computers were used. Because the uses were not particularly hampered by limited on-line file space or by limited communications, we have not come to think of them as important problems. But as the cost of computing declines, the uses change. In particular, more and more people can become computer users. The majority will need interactive access to files. From this comes the need for ever-increasing on-line storage, for aids to organize and maintain the storage, and for means to access and modify it whenever and from wherever.

As microprocessors become more powerful, many tasks of yesterday's large computers become possible for today's small computers. It would appear that soon everything will be done on small, even personal computers. But let us examine this more closely. Realize that the things we now attempt to do on small computers are what we first did on large computers. The large computers define our "appetite" — that which we consider feasible. In addition, large computers will increase in power, and new applications will become feasible. In the world of writing these include, in approximate order of magnitude, hyphenation, verification of spelling, and ever larger on-line dictionaries including dictionaries for foreign languages, encyclopedias, and eventually libraries. Large computers and conglomerations of computers will continue to define the "leading edge" of computing, even as it relates to working with text.

The four main premises of this discussion of architecture are the following:

1. The cost of computing (processing, memory, and on-line storage) is declining rapidly. This is true of both small computing (microprocessors) and large computing (mainframes).
2. The most important benefit to the average user comes from large on-line file systems that are easy to manage and manipulate.

3. The benefits of on-line storage are realized through digital communication.
4. The cost of digital communication continues to be high in comparison to the cost of computing.

PRINCIPLES OF ARCHITECTURE

A text system is useful only insofar as it helps us create, utilize, and refine text. Ease of building on work already accomplished is essential. Therefore, increasing numbers of files are needed on-line and the files must be readily accessible from more than one location. This has been amply demonstrated on systems with good facilities for text storage, text handling, and communications. The ARPAnet community is an excellent example.

The experience gained on systems with good display text editors is particularly relevant. The utility of such systems, as perceived by users, is so great that over time the systems tend to become largely text systems on which people do all their writing and much of their record keeping and communicating. The text editor becomes a universal interface to personal and shared information. Many applications that would customarily be handled by special programs, for example, data-base programs, are realized as ordinary text files manipulated by the text editor.

At the heart of these systems is a shared file system. It offers two major advantages over distributed file systems: low cost and ease of communication. Large disks and mass-storage devices continue to be the most economical way to keep text on line. Not only is the equipment less expensive (per character of on-line storage), but also the time spent by people in tending the storage is smaller (again, per character of on-line storage). The development of storage technology does not seem to affect the relative advantages of large storage units. It will barely keep up with the growing need for on-line storage.

As to communication between people, if the files for a group of people are kept in common storage, communication through files is automatically provided for. Because sharing of files is an excellent way to communicate, people do not even notice that communication could be a problem.

Communication between groups, that is, between people on different systems, can still be a problem. It can be solved by connecting the systems to one another. However, a satisfactory solution, one that is fast and reliable and is programmed adequately, is easier to come by if the number of systems that need to be connected is not very large. In that case, a single connection between large computers can be made to serve the communication needs of a large number of people. A campus-wide digital network that connects the major computers could provide an adequate solution. Such a network is now under development at Stanford.

The Elements of a Text System

For the purposes of this discussion, the elements of a text system are disks, processors, and user interfaces. See Figure 1.

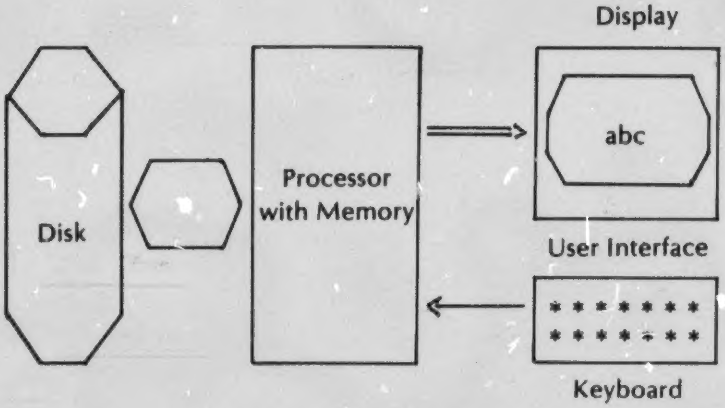

FIGURE 1. The elements of a text system.

Disk. A disk is an on-line storage device for files. Disks make text available for processing. Whether on-line storage is actually on disk is irrelevant, but for now disks prevail.

Processor. By processor is meant a computer (with memory), irrespective of its size. Processors and processing are required in finding text, in modifying text, and in presenting it to the user.

User Interface. For the present discussion, user interface is defined narrowly as the HARDWARE that the user views and manipulates — a display screen and the keyboard and whatever other input and output equipment there might be. "User interface" usually refers also to the methods of presenting material to the user and the command languages by which the user controls the system, i.e., software, and "terminal" refers to just the hardware. But since many terminals are programmable or "intelligent," and since the distinction between processing and interfacing to the user is critical to the present discussion, the word "terminal" is not used. Only displays and keyboard will be considered, as they are essential for working with text and do not seem to pose any major limitations.

All the elements — disk, processor, display, and keyboard — can come in one self-contained unit, such as a stand-alone word processor, or they can be distributed in different ways.

COMMUNICATION BETWEEN THE ELEMENTS

The elements of a text system must communicate with one another, as it is necessary to move text between a disk and a processor, between processors if processing is distributed, and between a processor and the user interface. The communication between a disk and the user interface is always mediated by processors.

Speed and reliability of communications are key architectural criteria. One side of the issue is, How are they achieved? and the other, Where are they needed the most? First, where are speed and reliability needed the most?

Communications between processors and files must be fast and reliable. This is obvious for batch programs, since the run-time communication does not even involve the user, but it is also true of interactive programs in which the processor finds information in a file and presents it to the user. Often only a small part of a file or set of files is viewed (and modified), but finding that part can involve searches and other processing over large files. This becomes more and more evident with time as the on-line storage of files and the variety of programs that deal with files increase.

Communication between a processor and the user interface is rather lopsided. In working with text, the user mainly types — at fewer than 10 characters a second — so that not much data are transferred in that direction. Coming in the other direction is the text that the user views. It is much more abundant but can be limited to the speed at which humans handle information. If the screen is small (24 lines), a rate of 100 characters a second is acceptable and 1,000 is luxurious. For a full-page screen (66 lines), 500 characters a second seem adequate and 2,000 ample. We assume, of course, that an efficient method is used for updating the screen. (Naturally, high-resolution graphics and animation in particular require very much higher transfer rates, but these are not essential in a text system.)

The widths of lines that connect the elements in Figure 1 represent the relative requirements for communication between the elements.

SPEED AND RELIABILITY OF COMMUNICATIONS

The speed and reliability of communication are affected by the distance between communicating units, the communications medium, and the complexity (and the cost) of the interfaces.

Disk Speed. Data transfer between a disk and a processor (a memory) can be in excess of 1,000,00 characters a second. But the distance covered is only tens of feet. Because the environment is controlled, the transfers are virtually error free. In subsequent discussion these speeds will be called disk speeds.

Terminal Speed. A (voice) telephone is the most readily available medium for accessing shared information. Speeds can go up to 1,000 characters a second with expensive modems but only up to 100-200 characters a second with inexpensive modems. Because the environment through which the signal travels is difficult to control, transmission errors are frequent. Similar speeds (100-2,000 cps) and reliability are achieved over shorter distances (up to a mile) on twisted-pair copper wire without modems. These speeds will be called terminal speeds.

Memory Speed. A third speed, one on which the speed of processing depends, is memory speed. Memory speeds are typically five to ten times disk speeds, and data transfers in memory are even more reliable than transfers between disk and memory (the environment is even better controlled).

Network Speed. Various network architectures come with speeds that fall between terminal speeds and disk speeds. Such shall be called network speeds. Again, reliability is affected by the networks' geographic span (i.e., the environment).

The cost of the interface goes up with the speed. Terminal interfaces are the simplest and also the least expensive. At the opposite end are memory and disk interfaces, which are the most expensive. Network interfaces fall somewhere in between.

In summary, we have:

	Speed, CPS	**Distance**	**Reliability**	**Cost of interface**
Terminal	100-2,000	5,000-.5 mi.	Low	Low
Network	1,000-2,000,000	5,000-.5 mi.	Medium to high	Medium to high
Disk	500,000-5,000,000	< 100 ft.	Very high	High
Memory	1,000,000-10,000,000	< 50 ft.	Very high	High

DISTRIBUTION OF ELEMENTS

With this background we can begin to examine where the various elements of a text system should be located.

The user interface should be where the user is likely to work. Often this is more than one location, particularly for faculty and students. If the location of the user interface can be made flexible, the question becomes, Where should the processor or processors and the files be located in relation to each other and to the user interface?

The first thing to realize is that terminal speeds (100-2,000 cps) are acceptable for communicating between a processor and the user interface but they are grossly inadequate for communicating between file storage and a processor, that is, for data transfers that need to take place when information is searched for. The second is that since we soon reach the capacity of humans to handle textual information, there is no compelling need to double the speed to the user interface every few years. Even today's terminal speeds can be made to serve the user interface adequately, if the architecture is properly chosen.

But disk space, disk speed, and the speed of processing do need to increase continually. For example, searches through files need to be faster as the amount of information grows. Fortunately, technology is developing the fastest precisely in these areas. Therefore, an architecture that provides much processing capacity next to a large file system is viable and increasingly more relevant as the use of on-line storage grows and as the need to share files grows. Whether the processing is provided by a single large (mainframe) computer, by several minicomputers, or by a large number of microprocessors is a separate issue to which we shall return later.

As regards communications, WHERE the text is displayed is less critical because an adequate speed to the user interface is relatively easy to come by. An architecture that depends on high speed is relatively easy to come by. An architecture that depends on high speed between a terminal and common storage or communications medium would therefore severely limit the utility of a text system, as it would be dificult to make services widely accessible. Working from home for example, would suffer.

Communications costs can be a factor in deciding where to store files. If the cost of staying on-line to a common storage is high, local storage of files may be the most practical answer. But then services will be reduced.

The above arguments point to an important conclusion: If a communications channel is adequate for the frequent transfer of files between a terminal and common file storage, it is more than adequate for the user interface. Therefore, *communications speed is not a factor in deciding where, in relation to the user interface, text files should be stored.*

ARCHITECTURE

The following architecture is based on the conclusions that files are best kept on large discs, processing is needed most where the files are, and the user interface can be removed from the place where processing is done.

NETWORK

The architecture assumes a high-speed digital network that connects the major campus computers to each other. The functions of the network are: transfer of characters between computer, transfer of files between computers, and transfer of mail between computers.

The importance of file and mail transfer is generally understood but character transfer is in fact the most important of the three. It makes it possible for a terminal to become an interactive terminal to any computer on the network and hence makes all the resources of the network available through the terminal. Furthermore, it is possible although inefficient — to base file and mail transfer on character transfer, but not vice versa. Not to provide for character transfer is therefore a serious deficiency in a network.

The system connected by the network are called nodes. Nodes can come in a variety of sizes and shapes. See Figure 2.

TEXT NODE OR CLUSTER

A text node is a basic, self-contained unit for text preparation and storage. It is a computer or a cluster of computers, together with terminals and printers, that share a file system. The unifying notion is the share file system.

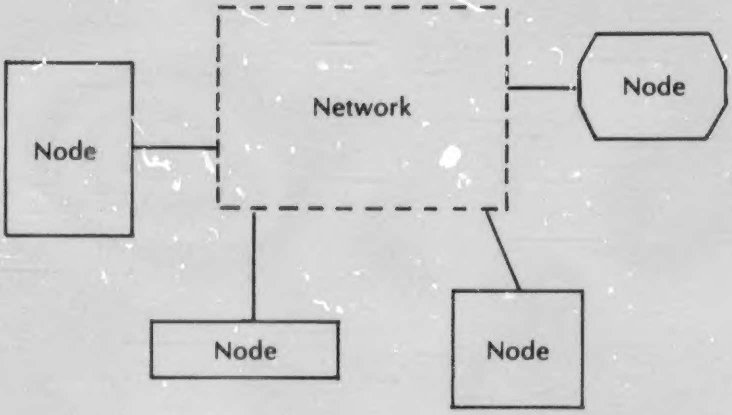

FIGURE 2. A network of nodes.

A text node could be dedicated to a department, school, or group of administrative offices, and it could serve 50-200 terminals and 10-40 printers.

A text node is made of three or four modules: a host module, which is optional, and writing, filing, and network modules. It therefore provides for text editing, printing, filing, and communications, and possibly for general computing. See Figure 3.

1. Host Module (optional). The host module is what normally is called a mainframe computer. It could be a timeshared general-purpose computer (e.g., IBM 3033) or a special purpose computer. Its relation to the writing module is that the two share a file system. A file prepared in the writing module would be readily available to the host and vice versa. The writing module is the natural means for reading and writing the text files of the host.

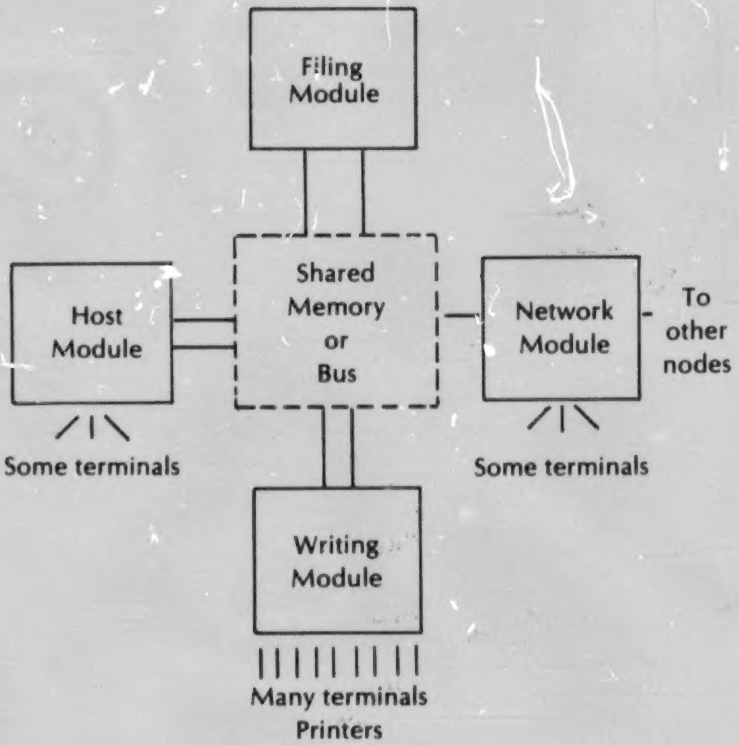
Filing Module
Shared Memory or Bus
Host Module
Network Module
To other nodes
Some terminals
Some terminals
Writing Module
Many terminals
Printers

FIGURE 3. The modules of a text node. The widths of connections represent relative traffic volumes.

2. **Writing Module** (editing computer or computers). The writing module is a "front-end" system with terminal ports that is designed for text editing. The idea is to isolate this most common interactive task and to place it in a processor that is then tuned for the task.

Besides text editing, the writing module would have two functions that are intimately involved with terminals: to serve as a switch and to provide display emulation to programs running in hosts. These functions are well defined and limited, but their value can hardly be overestimated. The diversity of computing resources at Stanford makes them important. Many useful programs run in specific hosts or require specific terminals. The utility of such programs is realized only by making them accessible, which is what these two functions are designed to do.

When a terminal is not used to edit a local file (a file that resides in the node), its character stream can be directed to the host of the same node or, over the network, to some other node. In both cases the writing module acts as a switch, and the user would not need to go to a different terminal to perform a different function, nor to carry files around.

Many uses of a text file require the repeated editing of the file and running a program with the file as input. Formatting, sophisticated searching, and checking for spelling are examples, as are the more conventinal editing and compiling of a computer program. The writing and editing would be done in the writing module and the running of the special program in the host module. The switching between the two modules would be done automatically by the node as the result of what program the user requests.

The second function, full-screen display service to programs running in hosts, compensates for the incompatibilities of display terminals. Popular terminals (for example, the IBM 3270) could be emulated on many other terminals, and the programs written for them could thus be made available on other terminals.

The writing module is the natural place for these two functions. Because of the prevalence of writing in people's work, text terminals very quickly become the way for people to do their work. If other computing services are available through the same terminals, they are easily accepted, and these services in turn increase the worth of a terminal to a person. Furthermore, the writing module would have the processing capacity for the character service and emulation because it would not, at the same time, be running the editor for the same terminal.

3. **Filing Module.** The filing module is shared by the host and writing modules, and each has high-speed access to the files. This is the crux of the architecture — that files needed by different processors or by different people or by the same person working at different locations be readily available without the need to duplicate files. (A conventional transfer of a file from one system to another amounts to duplicating it.)

Duplication of files, that is, the making of independent copies, coupled with the ease of modifying copies, is a major source of confusion in computer-based filing systems. How the files are related to one another is usually kept in people's heads. Better procedures and automated aids for keeping track of files will be developed, but they require good communication between the parts of the system and are therefore most easily come by on large, centralized filing systems.

A major shortcoming of stand-alone processors and small clusters is their filing system. There are problems in keeping enough files on line, in keeping track of files, and in making the files available to others. A word processor with "communications" does not come to grips with these problems. About the only thing provided for is the transfer of a file — and hence duplicating it! The limitations are so severe that a university-wide text system based on stand-alone word processors or small clusters could not be successful. However, the limitations are not noticed immediately because it takes time to accumulate files and to learn about the uses of on-line files.

4. **Network Module.** The network module connects the node to the digital network and provides for character and file transfers between nodes. The network module must therefore be able to communicate with the other modules of the node reliably and at a high speed.

Since the hardware and software for interfacing a computer to a high-speed digital network are rather elaborate and expensive, it is reasonable to concentrate a cluster of terminals — the terminals of a text node — in a single network interface. However, only a few of the terminals will use the network at any one time, as most of the work (writing, editing, and printing) is local to the node.

TERMINALS

The terminal must be suitable for display editing (editing in context). It need contain only the user interface (keyboard and display) and have appropriate functions for updating the display. As discussed earlier, the updating can and should be done by a processor that has direct access to the files.

Display. A small number of functions is sufficient. The following is a minimal set:

—Move cursor to a specified location on the screen,
—display a character (destructive overwrite),
—insert a character,
—delete a character,
—insert a line,
—delete a line,
—clear to end of line, and
—clear to end of screen.

Anything less than that makes updating very wasteful of communications. Ten or so additional functions that have been properly chosen make for a very comfortable set, but 40 could be excessive. The functions are chosen to minimize transmission by making maximum use of the text that is already in the terminal. Choosing the functions and their calling sequences is a relatively straightforward problem in information theory.

The simplicity of the minimal set is deceptive. Certainly, many more editing commands are needed in a good text editor. But we must not confuse editing commands, that is, the commands that the user types, with functions for updating the display, that is, the commands to the hardware that implement the editing commands. The relationship is akin to that between machine-language instructions and computer programs: The instruction set of a computer is extremely primitive compared to the functions that the computer is programmed to perform.

The display hardware can vary widely. Some important variables are:

—screen size (in lines and columns),
—line spacing (half lines for multilevel equations),
—size of the character set and whether characters can be defined in software (down loaded),
—character attributes (underline, bright, inverted video),
—color,
—number of cursors,
—memory for "extra" lines (ones beyond the current window) and for predefined (down-loaded) formats, menus, etc.,
—resolution of the display,
—ability to superimpose characters, and
—graphics.

Without going into the details of implementation, I shall illustrate their importance with an example. Many terminals have one eight-bit byte per display location and yet have three or four field attributes (underline, bright, inverted video, blink). Field attributes are easily confused with character attributes of the same name, but their use is much more restricted because of how they are implemented. Certain characters in the display-refresh memory signal a change in the attributes. They are usually ASCII control characters that are displayed as spaces. This makes it impossible to display two characters with different attributes without an intervening space, thus rendering the attributes worthless as indicators of type face.

With time, more and more of the desirable display characteristics will be available at low cost. They are the most visible of the changes to come from evolving technology, and they are important — next only to on-line file space and communications. The text system should therefore be designed for the easy adoption of new display technology. The design should be modular, with the dispaly physically separated from the higher level processor (the text editor) that manipulates the display. Experience with text editors that have been so designed bears this out: They can be readily adapted to new displays. TVEDIT of Stanford and EMACS of MIT are examples of such editors. (This should be construed as a comment about the use of the display by these editors apart from the appropriateness of the editors for any particular purpose.)

Keyboard. The notion of modularity applies also to the keyboard. The keyboard should be independent of the display (and vice versa), so that one of them can be upgraded or replaced without the need to consider the other. This means more than having a removable keyboard. The operation of the display should in no way be affected by the particular keyboard or the operation of the keyboard by the display. This principle is violated by terminals that have keyboards with an audible alarm (BEL) or keys that affect the display, for example, that move the cursor locally.

PRINTERS

A text node has printers for draft work and final copy. A line printer is sufficient for draft copy, but a letter-quality printer is needed for final copy. A printer can be shared by several terminals, the number depending on the speed of the printer. The notion of a printer "down the hall" seems reasonable. The writing module could drive the printers. Some hosts will have graphics printers and phototypesetters.

CONFIGURATION

TIMESHARED SYSTEMS

Many hardware configurations fit the general model. Simplest to recognize is a full-duplex timesharing system with a good file system and a good display text-editor. It is a text system in a microcosm, as has already been pointed out.

In a timesharing system, the modules of a text node are implemented within a single computer. Because of the other uses of the computer and because operating systems are not usually tuned for highly interactive jobs, response can deteriorate to the point where editing is unpleasant. Also, writing is sometimes construed as inappropriate use of the computer. All this has given timeshared text systems a worse reputation than they deserve.

The variability in system response due to competition for processing by compute-bound jobs can be eliminated by running the editor in a dedicated processor. The larger the processor and the better tuned it is for editing, the more editing jobs it can handle.

MULTIPLE PROCESSORS

The editing need not be done by a single processor. The node could have a dedicated microprocessor for each editing job if that were to prove most economical. What matters is that the processors be in the same place as the files so that communication between the editor or any other program and the files is fast.

DISTRIBUTION ALONG A HIGH-SPEED BUS

A configuration built around a high-speed bus, such as the Ethernet, is excellent for providing access to shared resources. The processors on one bus can be thought of as a node, with a gateway interface as its network module.

The bus brings in the possibility of distributing the file system. The problems that then need solving are how to make the file system appear to the user as one logical entity, and where to locate the files so as not to saturate the bus. for the bus is not a substitute for a disk channel. Even with this architecture, the less need there is to transfer files, the better.

The bus architecture does not eliminate the need for "remote" editing on terminals with nothing more than the user interface, because it is not practical to extend the bus indefinitely. Many people work in remote parts of the campus or at home, with the dial telephone as the only way to connect to the "world."

"INTELLIGENT" TERMINALS

A terminal with local editing but without local files (an intelligent terminal; see "Note of Terminology" below) fits the model poorly. It fits the model as regards files — they are in common storage — but it has difficulty with editing over standard terminal channels, for example, over a telephone line. The channels, even if sufficient for the user interface, are too slow and unreliable for distributed editing.

It is not immediately obvious that distributed editing would demand more of communications than does editing on a terminal with no local functions. If the terminal does editing within its local memory and another (remote) computer maintains the files, the character traffic generated by the user's typing and subsequent updating of the display is avoided. Instead, only the lines of text that have been changed in the terminal need to be transferred back to the remote computer. But that is difficult. It requires fast communication in both directions, not just from the remote computer to the terminal, and it requires reliable communication, much more reliable than the user interface alone. So much of the channel capacity is consumed in assuring reliability that the overall speed of editing is slower. This has been confirmed by experience with both kinds of editors. Other schemes for distributed editing have been suggested, but none that is simple to implement.

Another difficulty is adopting new display technology. Usually the entire terminal — the display, the keyboard, and the processor — and the software written to run in the terminal must be replaced, not just the display proper. (For some time to come, we can expect new terminals to be based on new microprocessors — hence the need to replace the software.)

STAND-ALONE WORD PROCESSORS

A conventional stand-alone word processor with communications, even at 2,000 characters a second, does not fit the model. Its files are not readily available to other processors or other users -- most of the files are not even on-line — and, at best, the word processor is only peripherally part of an on-line mail system. Usually no display functions are available to programs running in hosts, so to a host the word processor is simply a "glass teletype." For example, if a file that has already been transferred to the host needs a minor edit before the next run of a text formatter, the user has the choice of either editing a copy of the file in the word processor and transmitting it (once more) to the host or editing the file in the host with a different, line-oriented editor. If he does the latter, he must still, at the end of the session, transfer the updated file back to the word processor (we assume that that is where he keeps his files — otherwise the word processor has become but a primitive computer terminal). And file transfers are not free. They require attention and consume time.

NOTE ON TERMINOLOGY

Often the vocabulary available to us does not quite fit the things we are trying to describe. Listed below are several terms that tend to be misleading because they come very close to useful concepts.

Timesharing System. That we share the processing cycles of some computer is incidental (and sometimes detrimental). What matters is that we share information. It is more appropriate to speak of a **File Sharing System.** (Timesharing systems have traditionally been also file-sharing systems, which has been one of their major assets.)

Distributed Processing. We are more concerned with being able to access information than with where processing takes place. It is more appropriate to speak of **Distributed Access.** How that access is best provided is a separate question.

Distributed processing is easily confused with **Modularity** and **Redundancy,** two of the most useful principles of systems design. (Geographically) distributed systems tend to be modular and redundant — which is their virtue — but these two design principles can be applied equally to systems that are not distributed (systems in which only access is distributed).

Personal Computing. This word has positive overtones. It suggests that a computer is used on the user's terms for things the user wants to accomplish, and that the interaction is pleasing to the user. The confusion comes from assuming that this necessarily implies a person's own, private computer. Many personal computing needs are easier to meet on large, shared systems than on private computers.

Intelligent Terminal. This term suggests that something will take care of itself — as if by magic — when in fact what we have is a terminal with a small computer (a microprocessor), which invariably is more difficult to program for a given task than is a large computer. Instead, we might talk of a terminal with local functions, for example, local editing, or a **Programmable Terminal.**

Dumb Terminal. This term suggests that something is being done in an inferior fashion — that poor services are being rendered. It is more appropriate to speak of a **Slave Terminal,** meaning that the functions of the display are totally controlled from some remote processor. That a terminal is based on a microprocessor is not a distinguishing feature, because almost all terminals these days are. The terminology is not totally satisfactory, however, as "slave terminal" could be confused with "slave monitor," which refers to a display screen that shares the video signal of a master monitor.

SUMMARY AND CONCLUSIONS

A text system was defined as a medium for written communication: reading, writing, revising, filing, retrieving, printing, and distributing text. By architecture is meant the organization of the pieces of computing hardware that implement such a system.

Present computer technology is adequate for the implementation of a campus-wide text system, but the increasing requirements for on-line storage and the limitations of digital communications make some architectures better suited for the task than others. The text system described in this paper works well even with limited communications.

Of the various components of a text system, the user's terminal (keyboard and a video screen) is the least demanding of communications, and the files are the most demanding. Text is therefore processed by processors that are located at the file-storage site. Good display text editing on inexpensive terminals is possible under this architecture, it is relatively easy to develop and maintain software for the architecture, and the architecture adapts well to foreseeable technology, in particular to new display technology. Furthermore, a text system of this kind is easily integrated with other computing, which is important in a university with a variety of computing resources and needs.

This architecture is counter to the popular notions of storing files and doing the processing at the terminal. Attractive as such distributed architecture might appear, they are expensive and inflexible as institution-wide solutions.

9

Electronic Publishing for Educational Institutions

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1. Introduction

Documents of many kinds must be produced and distributed as key elements in the teaching, research, administrative and other activities of colleges and universities. These documents include simple memoranda of transient concern; lecture notes or camera ready copy that often contain complicated formulas, non-Roman alphabets, diagrams and pictures; course listings and library catalogs; forms and brochures for freshmen; newsletters for alumni; financial reports replete with charts and tabulations — the variety is enormous. Some can be typed, some need elaborate typesetting. Distribution may be to a few recipients close at hand; it may be world-wide. It may require stylistic and technical coordination with other sources as well. The work of students, faculty and administrators may be hampered or facilitated by the methods that are used to produce, transmit and distribute documents for the academic community and the methods chosen will affect institutional finances as well.

The overlapping fields of word and text processing, electronic typesetting and computer graphics, database storage and retrieval, electronic mail and document transfer, reprographics and computer networking are all electronic publishing resources of revolutionary impact. While colleges and universities have started to use these resources already, the full potential remains untapped. Use of electronic publishing in an academic environment moreover will stimulate further research in the application and techniques of the constituent technologies and in other areas — some seemingly remote and 'non-applied' — with latent benefit to technology and to basic knowledge alike.

Examples of several kinds of material produced electronically by the author and his associates, relevant to the academic community, are included at the end of this chapter.

The problems implicit in the use of electronic publishing must not be underrated, however. For almost two decades industry both has hailed the technology and damned it. Academe should take cautious advantage of electronic publishing — should not provide new fields for repeat performances of established patterns of disaster.

There are many elements of elctronic publishing that can be used in different combinations to meet varied objectives. Taking one particular configuration of equipment, or one particular mix of applications as absolutes can be very restrictive. Each of the elements mentioned in the next few sections should be reviewed, in its own right, regarding the role it can play and the attention it should receive in document production and distribution by a campus community.

2. Text Terminals and High Speed Printers

Today the staff of many academic institutions can access one or more general purpose computers, at least in principle, from terminals that are relatively inexpensive. In practice, to gain such access often depends on control of the funds needed to buy a terminal — minimally a few hundred dollars — and an institutional budgetary policy that absorbs the telephone costs. Faculty with research grants, and administrators with even minimal fiscal authority, may find that getting a terminal is the simplest, fastest route to mechanized document production for an individual member or a unit of the campus community. At the institutional level, however, there may well be more cost effective ways of spending pooled funds. For example, a redistribution of terminals already purchased or permission for more people to utilize existing equipment . . . measures such as these would allow significant progress in mechanized document production.

Several programs, such as SCRIPT and ATMS, are widely available to edit and to format documents that range from letters and memoranda to lengthy reports and dissertations. Low volume output can be produced on typewriter terminals in a user's office. High volume output can be printed on high speed printers in a central location, in upper and lower case and with special symbols if appropriate, In some universities this has become the standard way to produce theses already. Developments in dot matrix printers and the high speed xerographic and ink jet printers will make direct computer output play an ever increasing role on campuses. Output on at least one high speed printer already can be formatted by an adaptation of a powerful typesetting program. Several text terminals allow very small carriage movements, to draw graphs and diagrams. The dot matrix and ink jet printers also allow the inclusion of diagrams and charts as well as variable fonts in the output.

Portable terminals with bubble memory are having a dramatic impact on the work of an increasing number of faculty and other campus staff. It is possible now to type at home for an evening, edit off line, then transmit rapidly by phone to a computer without holding the household incommunicado for hours. These terminals also provide a way to transfer information electronically from one computer to another, albeit with some slight unwieldiness. This is a small price to pay, however, for the benefit of transferring material that really is needed on site today, but which could not be obtained otherwise until tomorrow.

Despite (or perhaps because of) increasing use of the power of the 'packaged' text processing programs, there is an increasing need for small text processing programs to meet the specific needs of individual projects, often to convert material that is already in machine readable form, into the input style of a packaged program. Courses on electronic publishing that include modules on the relevant programming techniques may well become a staple element of the computer curriculum. These would be of interest to people in many diverse fields, particularly in view of the increasing need of academicians to use the methodology in their work, and might serve to introduce humanists to the world of technology, and perhaps to industrial employment.

3. Word Processing Systems

The 'personalized' form letter has been the most familiar product of mechanized documentation since the pre-electronic days of the Flexowriter and similar paper tape controlled machines. There is now an almost bewildering proliferation of electronic systems, typically built around a mini or micro computer, with one or more typewriter or video input stations, and one or more printing units. Quite often a small phototypesetter is attached to the system. A communication link to transmit data to and from similar systems and/or general purpose computers now is usual, though it was surprisingly absent from many of the earlier electronic word processing machines.

A fairly standard basic repertoire of commands has evolved to retrieve prior versions or skeletons to form documents, to locate, insert, delete, replace and transpose material, to move back and forth within a text, and to format the output. Individual systems provide further facilities, such as sorting lists of items and performing arithmetical operations on numerical data. Some of the larger systems have powerful file maintenance provisions and general purpose programming capabilities.

Word processing systems have been developed primarily for office automation, with small electronic typesetters attached as an embellishment. The typesetting industry also has been developing electronic keyboard devices that make greater provision for standard typographic needs. Examples include: extra shift keys that allow four different characters to be produced by a single text key (instead of just the lower and upper case of an ordinary typewriter); keys for typographic functions such as making the output left or right aligned, or centered; and keys for different amounts of horizontal space. The 'human engineering' of these keyboards allows more complex as well as simple material to be typed much faster. Unfortunately the equipment developed for the printing industry has tended to be weaker than office automation equipment, as regards attachments for electronic general purpose computer systems. The need for extra keystrokes is often considered to be a lesser evil than communications weakness.

Variations and downright (or apparent incompatabilities between different word processing machines is an oft mentioned bugbear. Perhaps even more serious is the fact that many word processing machines and terminals are built with special capabilities that receive little use because of poor or untraceable documentation and apparent ignorance and disinterest on the part of the vendor personnel. Efforts are being made to establish clearing houses for 'nitty-gritty' technical information — for example how to transmit between a particular model of terminal and a particular operating system, and also between different terminals and between different operating systems. Efforts also are being made to establish standards for the future.

Even with good documentation, however, the amount of technical detail concerning input and output devices and software systems that can benefit or is downright essential to a user may be overwhelming. Distributed and shared expertise amongst a community of users seems essential to full utilization of the new technology.

4. Electronic Typesetting

The typesetting industry has been transformed in the last fifteen years by devices that display, on high resolution cathode ray screens, optical images of the successive lines or pages of material for publication, as they are to appear in print. The phototypesetting machines are controlled by computer generated magnetic tapes, or by on-line attachment to a computer, or by paper tapes punched by special keyboard units.

The low end of the price range for these machines is below $20,000; the high end is above $500,000. Some electronic systems used for newspaper and news magazine production contain batteries of keyboards and several typesetters attached to a central computer or network of minicomputers and cost several million dollars.

Smaller phototypesetters are being bought by universities, however. An article by James Reston last year developed the theme that these machines bring the ability to manufacture publications of graphic arts quality back into the domain of small budgets (1). Most electronic typesetters display characters by 'painting' the appropriate shapes onto the screen with an electron beam. The image that appears is recorded photographically on film or coated paper which is very convenient for offset printing. The typesetters differ in the variety of fonts that have been digitized, the number that can be mixed in a single run, the quality of output and the speed of operation. Among universities, the UNIX system developed at the Bell Labs is probably used most widely.

Electronic typesetting equipment also can be used on a service bureau basis at many typesetting companies. In this way, experience can be gained without capital expenditure. The author uses off-campus equipment extensively in his own work, in part because this provides access to installations that house standard commercial systems for which he designed the input language. Networked access to typesetting installations is likely to expand considerably in the next few years.

The composition languages used to specify font and formatting requirements are of paramount importance in electronic typesetting. The needs that these languages must meet were discussed recently at the Harvard Computer Graphics Seminar, in conjunction with the incorporation of diagrams and other pictorial material as part of the typesetting process (2). Several major efforts directed at the problem of composition languages have been conducted or started in university and scientific research environments — for example by the author when at MIT (3), by workers at the Bell Labs (4), and by Knuth at Stanford (5). The design of formatting languages is still a central problem of electronic composition.

Interactive computer graphics are used to an increasing extent for on-line 'dummying' — establishing where material will appear on individual printed page. This is necessary for very complicated page lay-outs, but it is too expensive and time consuming for lengthy routine publications, such as bibliographies and course listings. In general, it would be most convenient to process the material that has been keyboarded (or retrieved from databases or generated mechanically) through programs that impose formatting requirements which have been expressed in a simple fashion. The trouble is in making these requirements explicit anticipating all the special and exceptional cases that may occur — and having a language in which the needs can be expressed in a concise and intelligible way.

The field is still wide open for the development of composition languages that allow complicated typography to be described simply, and for the development of composition programs to support such languages. This in turn provides fertile ground and incentives for the exploration of new ways to process character-string information by using computers of present design, or by designing computers with radically different architecture.

The power of electronic typesetting is being enhanced considerably at present by the direct incorporation of graphs, diagrams and other illustrations. An expensive approach is used, for example, by the magazine U.S. News and World Report. Recent work, so far for line drawings, has achieved the same result inexpensively. The illustrations, in this latter work, are produced essentially as coalescing patterns or dots, using just the period symbol. In one approach, objects are defined by geometrical constructions. Points, straight line segments, arcs of conics, elementary functions and of polynomial and other series are specified in simple ways (e.g. a point by its coordinates, or as the intersection of two named lines, a circle by its center and radius or by three points through which it passes, etc.). Further commands allow composite objects to be specified in terms of constituent items, and to be transformed geometrically.

These tactics can expedite the production of camera ready copy considerably, avoiding the need for manual art work, and cutting and pasting. Injecting graphs and diagrams into the input for typesetting will be particularly beneficial when the relevant data are computer generated, and otherwise would have to be plotted mechanically on graphics devices to be stripped in for final publication.

The ability to typeset drawings in this way also opens up the potential for small typesetters attached to word processing systems to be used as hard copy graphic output devices.

5. Computer Graphics

Over the last two years, the quality to cost ratio of computer graphics equipment, the number of installations, and the effectiveness and diversity of uses have risen considerably, and will continue to rise as a 'cooperative phenomenon.' The production of 'pretty pictures' instead of massive printouts does not solve any administrative problems. Where the content and the design of the summary charts and diagrams has been properly planned, however, the use of graphics output can expedite the production of material for policy meetings and administrative reports. The effectiveness of these may be greatly enhanced with material which, without computer graphics, would not have been produced.

The use of graphic output devices has considerable potential too, in the production of instructional materials (such as solutions to math problems, projections of molecular structures that are difficult to visualize, maps that show the progression of historical events). Computer graphics is used extensively in academic research already to display, for example, computational results in the natural and social sciences. Interactive graphics also is used in a few institutions to help teach architectural, engineering, and artistic design. Computer animation is an aspect of computer graphics that offers considerable potential for exploration in an academic environment too. The cost of equipment needed for this work, and its academic implications, are well within the bounds of funding possibilities. The inclusion of graphic arts quality text in the output of computer graphics devices also is receiving increased attention, e.g. by Poage and Hazony (6).

The total spectrum of graphics equipment — digitizers, hard copy output devices, monochrome and color displays, vector and raster equipment and so forth can seem somewhat overwhelming, and the text books do not keep pace. Some helpful overviews — comprehensive and intelligible — are being provided now, for example at the annual meetings of the National Computer Graphics Association and at the Harvard Computer Graphics Seminar. (7)(8)

6. Communications and Computer Networking

Electronic mail and document transfer may, in time, be the major use of data communication and computer networking. Electronic mail does seem to be the most extensive application of ARPANET to date. Much needs to be done, however, to make such electronic information transfer easier, more dependable, and less expensive. Efforts to use it in the production of the Newsletter of the ACM Special Interest Group in Office Automation, which the author edits, have been quite salutary. Comments at the N.E.C.C. in June on the attempts to download software from a central site in the Minnesota Educational Computer Consortium to distributed microprocessors were discouraging (9). There is hope, however. Voluminous text information is transmitted by wire service in the news industry and much of it goes straight into computer systems. This illustrates a need for interdisciplinary and inter-industry discussion. The EDUNET Network Access System for the Apple Computer is an important step forward in this general area. (10)

7. Analysis and Planning

High technology only creates more problems, and at considerable expense and trauma, unless it is used with intelligence and understanding of the applications and of the critical methodological issues. Society survived administrative successes and administrative disasters before the invention of the terms "operations research" (unheard of by a surprising number of people today), "systems analysis" and "human engineering," activities which like speaking prose can be practiced or abused, without awareness of the rubric. This does not decry the benefits of formal training in the methods of modern management, but form without substance can be even more harmful than a lack of substance made conspicuous by lack of form.

Making a campus wide survey of what is done and needed (as well as what is done but not needed, and what is needed but not done) in the document production, copying, distribution and utilization can be most informative, and likely to suggest significant cost savings (quite often just by pruning) without the introduction of new technology. Because advocates of mechanized domentation often propose such a survey as a first step to some further plans, administration may find it interesting to suggest that the paper work of the survey be handled in an inexpensive mechanized way.

Physical rearrangement, redistribution, and revised policies concerning access to existing resources may expedite documentation activities considerably by reducing expenditures, and by providing needed services. Getting a desk moved from one office to another can present insuperable difficulties. When this is the case, however, there are likely to be deeper institutional problems which high technology is more likely to compound that to resolve, and which need to be tackled first.

Student aides to staff a copying center, to provide an intra campus messenger service, and to type text and other material into electronic systems; the rearrangment of offices to provide proximity to shared resources; a bursting machine to separate computer output; a reducing copier to allow consistency with basic office storage units; a power stapler — these low cost, non-electronic, seemingly mundane services can help an institution enormously, reducing the erosion of faculty and administrative time in document production and distribution.

If the consideration of such matters has to be justified in esoteric terms, there are learned treatises which can be worked on operations research, systems analysis and human engineering that cite such seeming trivia. An interesting paper at the AFIPS Office Automation conference in March dealt precisely with the physical arrangement and clerical support activities of departments involved in high technology work.(11) Note also should be taken of work in program at MIT and elsewhere to develop languages for the description of document and information flow in real office situations, as an element of effective mechanization. (12)

Readers embarking on in-house document preparation should take note of the SIGCA Newsletter which has published the very detailed proposals for in-house document preparation at Stanford University and at Rome Air Development Center. (13), (14)

Once planning is completed, administrative decisions must be made, possibly involving heavy commitments for equipment and personnel. All too often, the introduction of high technology to avoid a budget deficit has led inexorably to even greater deficits, with the relentlessness of Greek tragedy. A paradox seems to be built into the use of data processing to cut costs, which in time may extend to allied areas such as office automation. Industrial salaries for data processing personnel are geared to the capital expenditure on equipment, and to the size and cost of staff for which they have administrative responsibility. Asking a data processing manager to reduce staff or equipment is tantamount to asking for a voluntary reduction in potential income. Establishing a system of rewards that presents no conflict between an individual avoiding or reducing staff on one hand, and harming his or her earning power on the other, may be a matter in which academe can set a helpful precedent for industry.

A gradual build up of new resources, with maximum use of outside service bureau facilities, leased equipment and minimum commitment to staff, has obvious attractions, but can be frustrating and unsettling to key personnel. In the last analysis, decisions have to be based on inter-personal judgements and, hopefully, on an awareness by top administrators of the critical issues which they should question, and concerning which they should be 'snow proof.'

8. Administrative Document Production and Distribution

The potential for office automation in academic administration has been systematized and presented authoritively by Kanerva and Siegman, in the Stanford report published in the SIGOA Newsletter.(13) But in the current context there are other concerns as well.

Mechanized documentation will be a boon if, for example, it ensures that the agendas or the notification of meetings reach the participants before the meetings have been held. Considering the flood of junk mail that reaches the average household daily (and contributes to the cost of first class mail) and the predilection of academics occasionally to bombard colleagues with verbiage, what kind of Sorcerer's Apprentice situation are we likely to encounter. When polemic and rhetoric become distributable at the press of a button? How do we contain the potential for databanks of cliches, quotations, recriminatory allusions and pet predictions to be stored and tapped mechanically. How will we stem an ever rising flood of memoranda issued in retaliatory and pre-emptive strikes, once the tactic catches on? What file security measures will be needed to ensure that the wise saws and instances of one antagonist's database remain uncorrupted by the opponents. . . .

Electronic conferencing is hailed as a way to confer without having to travel. Fortune magazine recently published an article on the increasing amount of time that industrial executives have to spend in conferences. Teleconferencing now opens the door for companies to be paralysed nation wide, instead of just at corporate headquarters by 'command performance' discussions. Is Academe immune from this kind of problem?

Office procedures change and libraries buy books. It is nice to know how to fill out a travel voucher before spending an hour using a style that has been superceded. It is nice to know that last years issues of the Journal of Anti Social Science and Impolitic Misadministration have now arrived. It does take time to open a spring binder and insert an addendum or replacement sheet. But how often should we receive complete revisions of a fifty page procedures manual, or a library catalog, that differs from its predecessor by just one or two details which may not even have been flagged?

Administrative data processing units now are rich with, and/or groaning under, tape and disc files of information that would be useful in printed catalog form. Woe betide the eager academic agog to show the power of the new technology in achieving this goal. The better the appearance of the end product, the more conspicuous become the errors of content, and the larger the audience to observe and offer helpful advice. What may start as a seemingly simple extraction of data from what is expected to be a clean file, with a simple program to convert from capitals to upper and lower case and to insert formatting codes, can rapidly deteriorate into a nightmare of clerical minutae, inexplicable inconsistency, repeated reversal of proposed requirements, and an overall contribution to mutual goodwill and an image of the activity that are not necessarily positive.

Putting things in writing in advance is a simple, good dictum, but little help when the members of a bureaucratic unit cannot verbalize what they learnt (or think they learnt) to do by rote thirty years ago, and have modified and muddled ever since. It is quite human to have reservations about making a peculiar expertise known with possible prejudice to personal indispensability. It may well be that a university needs someone with the tenacity and skills of a faculty member to unscramble a clerical quagmire. Retrenched classes and bureaucratic costs may make this desirable, if the contribution of the faculty member can be recognized and rewarded either within the campus or as a step to industrial management. But faculty should avoid boxing themselves into interminable clerical cleanups that produce a unique product, with a total relapse to chaos thereafter.

Of course, not everything that can go wrong always does. Some a.d.p. filed are clean in academe, just as they are at times in industry. As a working rule, however, this should be accepted as a pleasant surprise, after expecting the worst, rather than the other way around.

9. Document Production for Instructional Use

The production of notes to be given to students including work assignments, quizzes and examinations, and entire text books can be facilitated by text editing resources. Drafts can be revised and the final version formatted. With output devices of sufficient flexibility, it is possible to incorporate mathematical, chemical and other formulas; phonetic, Old English, Greek, Cyrillic and other non-Roman alphabets; music, labanotation and other special symbolism; tables, charts, diagrams, line drawings and other pictorial material.

Completed texts can be submitted for publication in machine-readable form, after editorial changes have been made. Authors with access to electronic typesetting equipment will be able to provide camera ready copy to publishers or, if they wish, bypass the commercial publishing houses. This capability may have interesting effects on the financial structure of educational publishing, with a reduction in the cost of books to students, and an increase in returns to the authors. Universities may well be advised to review the implications of this kind of situation and establish guidelines that are fair to all concerned, before problems arise inadvertently. The impact of recent I.R.S. rulings on the publishing industry uderscore the benefits and perhaps need for direct publication of specialized material by faculty members.

It is possible in principle to transmit instructional material, that has been put in machine readable form, from one computer to another, for reprinting at different sites, perhaps after editorial modification for local needs. Again some principles will have to evolve concerning rights of authorship — both with regard to financial interest and responsibility for content — and security to prevent, for example, unauthorized copying of texts or premature access to examination questions.

The time and effort needed to produce variant course notes — e.g. extracting material for a survey course from material for more detailed courses — will be reduced considerably. The mechanics of updating a set of course notes for a new semester, or a text book for a new edition, will become simple, rapid and inexpensive, and at times feasible when it would have been impossible otherwise.

So far we have considered just the text editing and to some extent the graphics drawing and electronic typesetting capabilities of the new technology. Text processing of a more general kind can benefit the instructional process in still further ways. Many classroom and individual study situations can be helped by the provision of detailed, illustrative material that requires routine but tedious effort to construct.

For example, many students will grasp a concept or a process in mathematics, or grammar, or computer science, by inspecting a large number of examples, and then being told the commonality and underlying principle. The computer can be used to generate such sets of worked examples and comparable illustrative materials.

The author of this note first gave detailed attention to the problem when teaching matrix notation to graduate humanists who wanted a simple demonstration of the advantages of the notation in terms they would understand. The upshot was a set of examples of two state linear dependence that were very tedious to write but received enthusiastically by the students, who grasped the principles quickly as a result.

There are many facets to instructional text production by computer — worked examples, as just discussed; massive sets of drill questions, with or without solutions; and material targetted to different regional or cultural background. The tactic of the personalized form letter provides a useful starting point. Consider, for example, the following simple computer science problem.

> The favorite appetizers of the chef at the San Juan restaurant are Bachalaitos, Empanadillas and Platanutre; his favorite main dishes are Arros con Pollo, Sancocho, Mondago and Pasteles; and his favorite desserts are Tinbleque, Linbe, Majarete and Pasta de Guayava. The restaurant will offer a different combination of an appetizer, a main dish and a dessert from this selection at a special rate, on successive days after their grand reopening next month. Write a program to print the menus.

This can be adapted to a host of target groups simply by changing the name of the restaurant and the names of the dishes. Corresponding sets of examples can be produced in other languages simply by changing the skeleton in which these items are embedded. Word processing machines and text editing programs can churn out sets of variations, from the skeletons and variant items, in just the way that form letters are produced.

American students learning foreign languages, as well as recent immigrants can be helped by instructional material that embeds language invariant items within text, varied for country of origin or interest, and juxtaposed with the corresponding material in English. Technology can help produce this.

The mechanical production of questions, and the analysis of human responses and the continuation of the dialog, have received considerable attention in relation to interactive computer aided instruction. The central problem seems to be the development of suitable 'authoring languages.' Such languages need to express the common features and constructional algorithms for sets of examples that vary to a much greater extent than simple substitution of variant items into an invariant framework. One approach to the problem — the use of 'constrained generative syntaxes' is being developed by the author and his colleagues under support from the Comprehensive Assistance to Undergraduate Science Education Program of the National Science Foundation.(15)

10. Electronic Publishing and Academic Research

The techniques of word and text processing allow rapid and inexpensive editing of drafts of research papers, survey articles and complete monograms that have been recorded in machine readable form. Access to electronic typesetting permits the production of camera ready copy of graphic arts quality with implications that parallel those mentioned in the preceding section. Results of computations and other mechanized processes (e.g. permutations in textual analyses, mathematical formulas constructed by algebraic manipulation programs, bibliographies retrieved by on-line search of data bases, diagrams produced on graphics devices, computer programs that have been validated, together with the test data that actually was used and the corresponding results) can be incorporated in the output without the time and effort of retyping or the danger of transcription errors.

Electronic transmission to the production centers of professional journals will develop — though even amongst users of high technology there still are wide variations in ease of access to electronic transmission facilities. For a university that has an

ARPANET node, this is relatively simple, but the material that is received must be inspected to insure that blocks were not lost or garbage lines incorporated.

If a file has been stored on an author's computer, it is possible to sign on from a terminal on a UNIX system, using the author's protocol, and to bring the file into the UNIX by a simple command. This throws the burden of using multiple protocols onto the central site, and the telephone costs can be quite high for coast to coast transmission.

IBM compatible tapes still seem the most dependable way of transmitting bulk material in machine readable form for a majority of people even though mail and messenger services may be slow. Cassettes and floppy disks are a nuisance — even if a journal processing center and a group of authors have access to word processing machines of the same vendor, another author may have trouble doing likewise. This also poses a burden to a processing center to have to search around for local installations of yet further models of equipment.

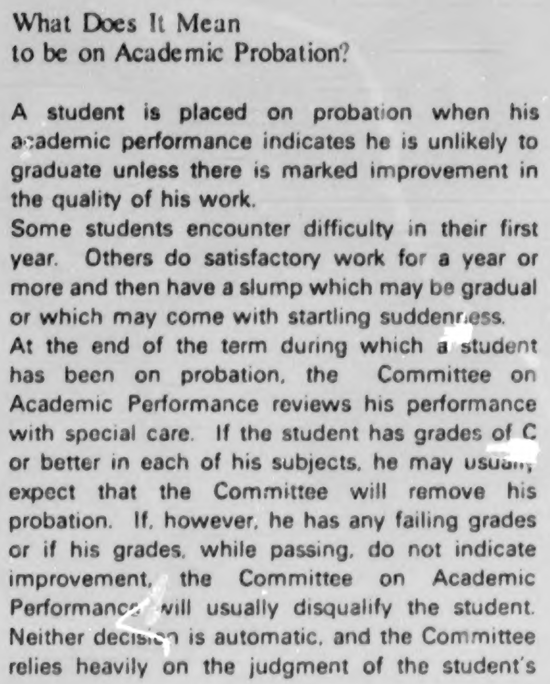
A variety of problems arise in practice — for example when a processing center receives a line by line image of the way an article was printed on its author's word processing system, a program may be needed to detect centering and indention, and to replace these by formatting codes of the new environment. This kind of experience is all to the good — it enables the field to evolve.

The products, effects and methods of electronic publishing, in the wider interpretations considered here, also may be subjects of research and artistic endeavour. For example: research on the educational impact of computer generated teaching materials; exploration of computer typesetting and computer graphics as vehicles for artistic design; new languages to describe formatting needs, office procedures and text manipulation; networked microprocessor systems for non-numeric information processing; physical principles on which new output devices can be based; economic and sociological research on the impact of the new publishing technology. Just as the

Library of Congress has a Center for the Book to study literary, social and aesthetic aspects of publishing, so too may some universities establish interdisciplinary centers, in which aspects of electronic publishing are pursued in a context that links the physics and chemistry of the printing materials of yesterday and today with the social dynamics of communication and information transfer. In an academic setting that combines technology with aesthetics as a catalyst, the multiplicity of topics that would occur naturally could be almost endless.

Fifteen years ago, we discussed the possible role of computer typesetting in an academic environment.(3) Time has passed, and much has happened to electronic publishing, in industry and education alike. But discussion of its role in academe has not ended — perhaps this meeting is the start of a new chapter.

In-house typesetting for a publications office — from the pamphlet for students on academic probation produced at MIT in 1963 on a computer controlled Photon machine.



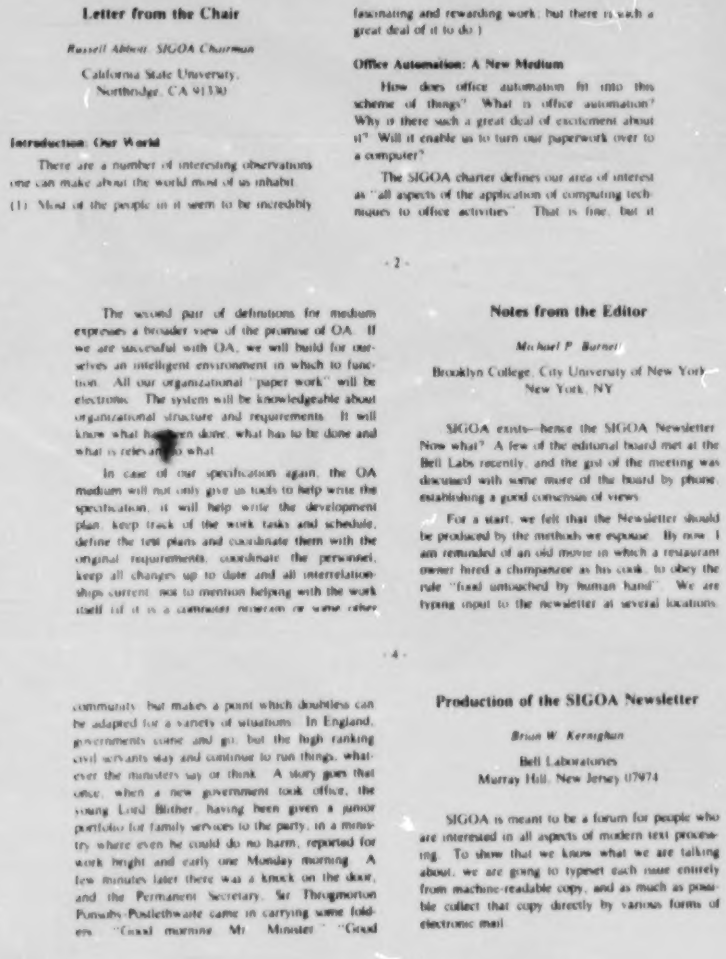
What Does It Mean
to be on Academic Probation?

A student is placed on probation when his academic performance indicates he is unlikely to graduate unless there is marked improvement in the quality of his work.

Some students encounter difficulty in their first year. Others do satisfactory work for a year or more and then have a slump which may be gradual or which may come with startling suddenness.

At the end of the term during which a student has been on probation, the Committee on Academic Performance reviews his performance with special care. If the student has grades of C or better in each of his subjects, he may usually expect that the Committee will remove his probation. If, however, he has any failing grades or if his grades, while passing, do not indicate improvement, the Committee on Academic Performance will usually disqualify the student. Neither decision is automatic, and the Committee relies heavily on the judgment of the student's

Electronic Production of professional publications — portions of the first issue of the Newsletter of the ACM Special Interest Group in Office Automation. The material is typed by authors on word processing systems and computers which they can access easily. It is collected electronically at the Bell Labs, edited on-line, and typeset electronically, by Brian W. Kernighan on a UNIX system.



Letter from the Chair

Russell Abbott, SIGOA Chairman

California State University,
Northridge, CA 91330

Introduction: Our World

There are a number of interesting observations one can make about the world most of us inhabit.

(1) Most of the people in it seem to be incredibly fascinating and rewarding work; but there is such a great deal of it to do.)

Office Automation: A New Medium

How does office automation fit into this scheme of things? What is office automation? Why is there such a great deal of excitement about it? Will it enable us to turn our paperwork over to a computer?

The SIGOA charter defines our area of interest as "all aspects of the application of computing techniques to office activities". That is fine, but it

- 2 -

The second pair of definitions for medium expresses a broader view of the promise of OA. If we are successful with OA, we will build for ourselves an intelligent environment in which to function. All our organizational "paper work" will be electronic. The system will be knowledgeable about organizational structure and requirements. It will know what h[illegible]en done, what has to be done and what is relevan[illegible]o what.

In case of our specification again, the OA medium will not only give us tools to help write the specification, it will help write the development plan, keep track of the work tasks and schedule, define the test plans and coordinate them with the original requirements, coordinate the personnel, keep all changes up to date and all interrelationships current, not to mention helping with the work itself (if it is a computer program or some other

Notes from the Editor

Michael P. Barnett

Brooklyn College, City University of New York
New York, NY

SIGOA exists—hence the SIGOA Newsletter. Now what? A few of the editorial board met at the Bell Labs recently, and the gist of the meeting was discussed with some more of the board by phone, establishing a good consensus of views.

For a start, we felt that the Newsletter should be produced by the methods we espouse. By now, I am reminded of an old movie in which a restaurant owner hired a chimpanzee as his cook, to obey the rule "food untouched by human hand". We are typing input to the newsletter at several locations.

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community, but makes a point which doubtless can be adapted for a variety of situations. In England, governments come and go, but the high ranking civil servants stay and continue to run things, whatever the ministers say or think. A story goes that once, when a new government took office, the young Lord Blither, having been given a junior portfolio for family services to the party, in a ministry where even he could do no harm, reported for work bright and early one Monday morning. A few minutes later there was a knock on the door, and the Permanent Secretary, Sir Throgmorton Ponsoby-Postlethwaite came in carrying some folders. "Good morning, Mr. Minister." "Good

Production of the SIGOA Newsletter

Brian W. Kernighan

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Murray Hill, New Jersey 07974

SIGOA is meant to be a forum for people who are interested in all aspects of modern text processing. To show that we know what we are talking about, we are going to typeset each issue entirely from machine-readable copy, and as much as possible collect that copy directly by various forms of electronic mail.

Faculty telephone directory — Columbia University, 1977. Produced by M.P. Barnett in collaboration with Mr. Daniel I. Cacici and members of the Publications Office.

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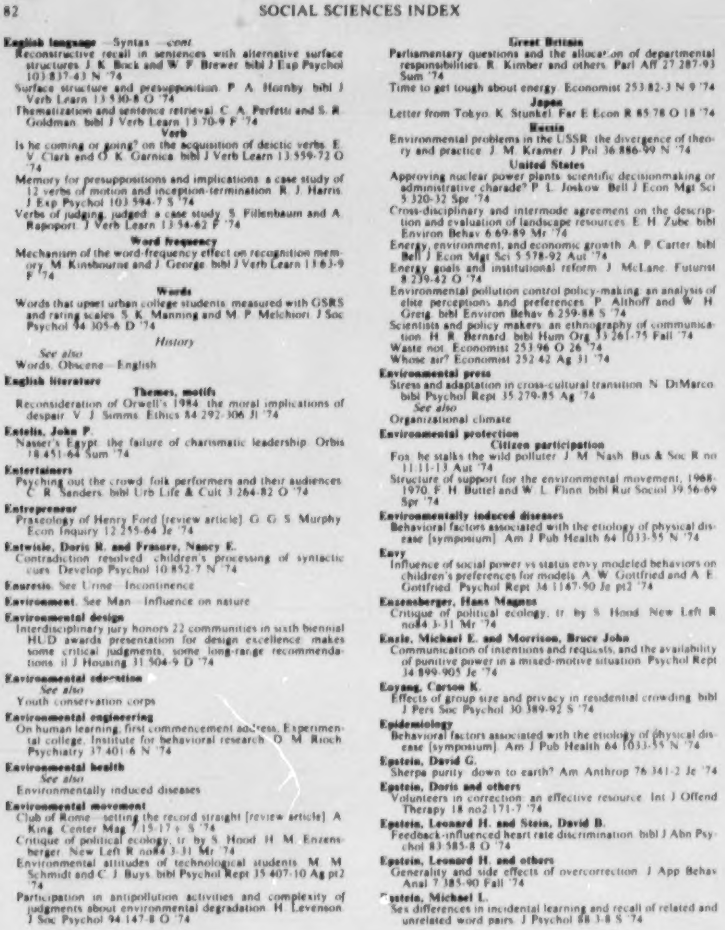

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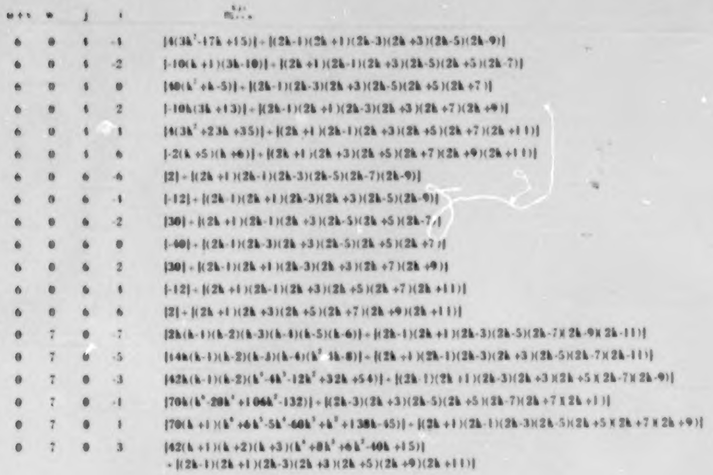
		DSS CHARACTERISTICS						
ORG. VARIABLE	VARIABLE CHARACTERISTIC	REAL TIME	TIME SHARE	AUTO MSG	GRAPHICS DISPLAY	ALPHA DISPLAY	AUDIO ALARM	LARGE SCALE DISPLAY
GROUP	FORMAL:							X
STRUCTURE	FORMAL:							
	LINE					X	X	
	STAFF				X		X	
	FUNCTIONAL							
	MATRIX			X				
	UNIT							
	INFORMAL:							
	CENTRALIZED							
	CONSULTATIVE		X					
	TRANSACTIONAL							
	DELEGATED							
	DECENTRALIZED							
	LINK							
TECHNOLOGY	HIGH							

Mathematical formulas constructed mechanically by algebraic symbol manipulation, and typeset electronically without manual transcription. From "Mechanization of tedious algebra — the coefficients of theoretical chemistry," H.D. Wactlar and M.P. Barnett, Communications of the ACM, 7(12) 704, 1964.



m+n	m	j	i	[illegible]
6	0	4	-4	$[4(3k^2-17k+15)] \div [(2k-1)(2k+1)(2k-3)(2k+3)(2k-5)(2k-9)]$
6	0	4	-2	$[-10(k+1)(3k-10)] \div [(2k+1)(2k-1)(2k+3)(2k-5)(2k+5)(2k-7)]$
6	0	4	0	$[40(k^2+k-5)] \div [(2k-1)(2k-3)(2k+3)(2k-5)(2k+5)(2k+7)]$
6	0	4	2	$[-10k(3k+13)] \div [(2k-1)(2k+1)(2k-3)(2k+3)(2k+7)(2k+9)]$
6	0	4	4	$[4(3k^2+23k+35)] \div [(2k+1)(2k-1)(2k+3)(2k+5)(2k+7)(2k+11)]$
6	0	4	6	$[-2(k+5)(k+6)] \div [(2k+1)(2k+3)(2k+5)(2k+7)(2k+9)(2k+11)]$
6	0	6	-6	$[2] \div [(2k+1)(2k-1)(2k-3)(2k-5)(2k-7)(2k-9)]$
6	0	6	-4	$[-12] \div [(2k-1)(2k+1)(2k-3)(2k+3)(2k-5)(2k-9)]$
6	0	6	-2	$[30] \div [(2k+1)(2k-1)(2k+3)(2k-5)(2k+5)(2k-7)]$
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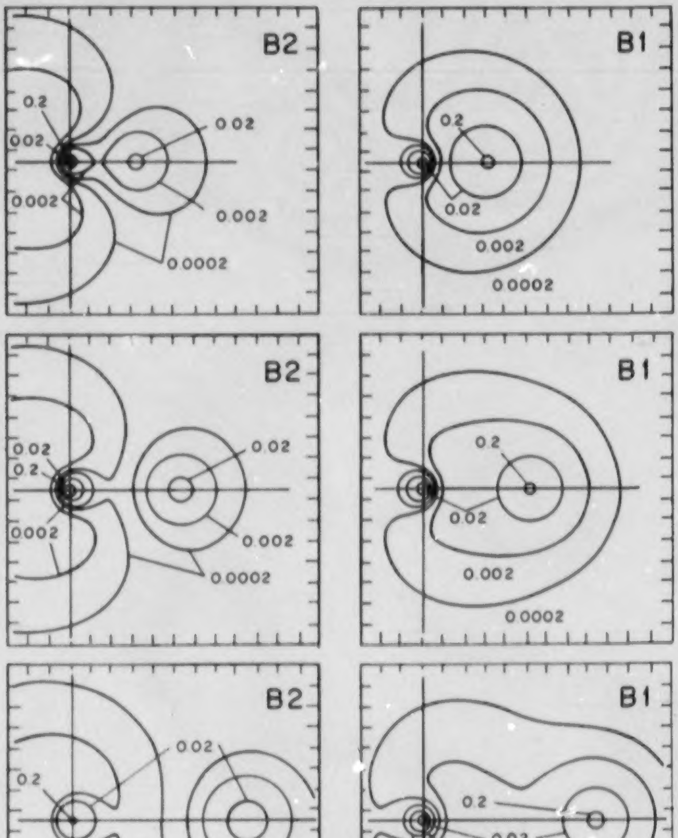
6	0	6	2	$[30] \div [(2k-1)(2k+1)(2k-3)(2k+3)(2k+7)(2k+9)]$
6	0	6	4	$[-12] \div [(2k+1)(2k-1)(2k+3)(2k+5)(2k+7)(2k+11)]$
6	0	6	6	$[2] \div [(2k+1)(2k+3)(2k+5)(2k+7)(2k+9)(2k+11)]$
8	7	8	-7	$[2k(k-1)(k-2)(k-3)(k-4)(k-5)(k-6)] \div [(2k-1)(2k+1)(2k-3)(2k-5)(2k-7)(2k-9)(2k-11)]$
8	7	8	-5	$[14k(k-1)(k-2)(k-3)(k-4)(k^2\ 4k-8)] \div [(2k+1)(2k-1)(2k-3)(2k+3)(2k-5)(2k-7)(2k-11)]$
8	7	8	-3	$[42k(k-1)(k-2)(k^4-4k^3-12k^2+32k+54)] \div [(2k-1)(2k+1)(2k-3)(2k+3)(2k+5)(2k-7)(2k-9)]$
8	7	8	-1	$[70k(k^6-20k^4+106k^2-132)] \div [(2k-3)(2k+3)(2k-5)(2k+5)(2k-7)(2k+7)(2k+1)]$
8	7	8	1	$[70(k+1)(k^6+6k^5-5k^4-60k^3+k^2+138k-45)] \div [(2k+1)(2k-1)(2k-3)(2k-5)(2k+5)(2k+7)(2k+9)]$
8	7	8	3	$[42(k+1)(k+2)(k+3)(k^4+8k^3+6k^2-40k+15)]$ $\div [(2k-1)(2k+1)(2k-3)(2k+3)(2k+5)(2k+9)(2k+11)]$

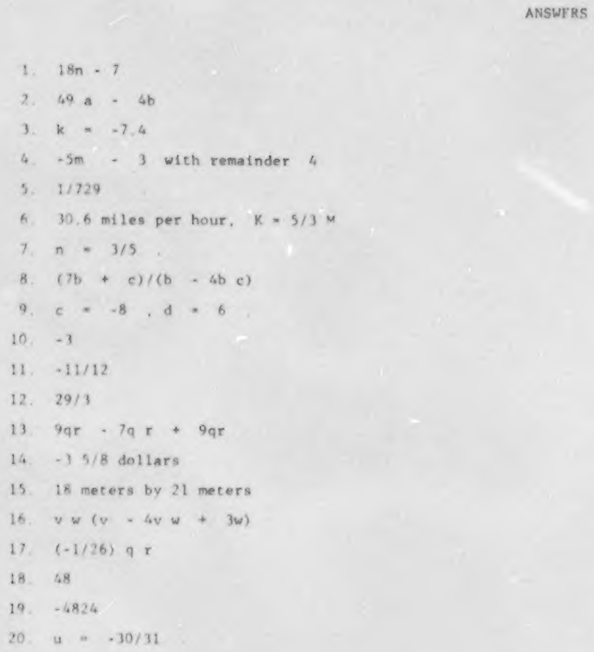
Graphical display of results of numerical computations — contour plots of electron density in a chemical reaction, computed theoretically and displayed on an early CRT output device. This was recorded photographically, and incorporated in a journal article ("A group orbital study of Lithium Hydride," I.G. Csizmadia, B.T. Sutcliffe, and M.P. Barnett, Canadian Journal of Chemistry, 42, 1645, 1964)



Computer generated algebra quiz — J.J. Kovacic and S.E. Lipsey, Brooklyn College, 1980. Hundreds of different problem sets, on a variety of mathematical topics, have been produced by the programs that generated this set of questions. These have been used by nearly two thousand students during the past two years. This work is part of the project supported by the Comprehensive Assistance to Undergraduate Science Education (CAUSE) program of the National Science Foundation, grant #SER 78-06321.

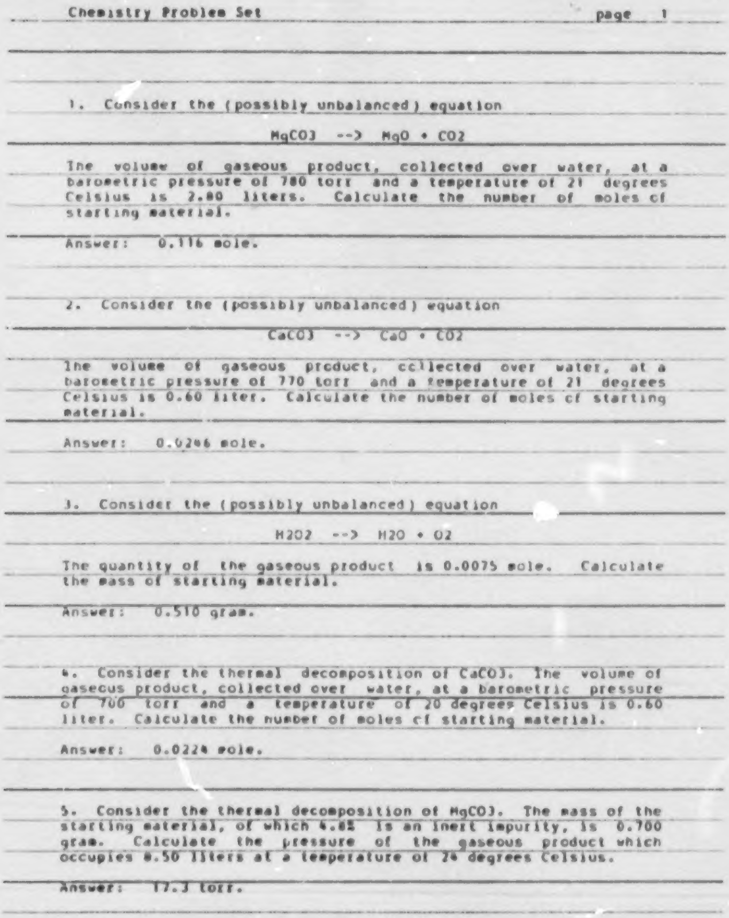
```
                                        ALGEBRA PROBLEMS

 1.  A rope is cut into three pieces.  Suppose that the length of the
     smallest piece is n .  If the length of the second piece is 7 more
     than 14 times the first, and the third is 14 less than 3 times the
     first, find the length of the rope in terms of n .

 2.  Multiply out:  (-7a + 2b) (-7A - 2B)  .

 3.  Find k correct to 2 decimal places:
     2.31k + 7 (28.18k - 14.53)  =  216.47k + 23.43  .

 4.  Divide 30m - 7m - 11 by -6m + 5  .

 5.  Find the p-th power of -1/3, if p = 6  .

 6.  The formula for converting speed limits in kilometers per hour (K)
     to miles per hour (M) is M = .6K  .
       1)  Find M when K = 51  .
       2)  Solve for K in terms of M  .

 7.  Solve for n and check:  13 + 18n  =  17n + 16 - 4n  .

 8.  Reduce (-56b - 8c)/(-8b + 32b c)  .

 9.  Solve and check:   -10c -  7d   =   38
                          5c + 10d   =   20  .

10.  Find the quotient if -6 is divided by 2  .

11.  Reduce  -110/120 to lowest terms.

12.  Find the average of 97 , 7 , -75  .

13.  Find (5qr - 3 q r + 6qr ) + (3qr + 4qr - 4q r )  .

14.  Suppose that when the stock market closed one day, Resorts Intercity
     stocks were selling for 31 7/8 dollars per share.  Suppose that at
     the close of the next day, Resorts Intercity was selling for
     28 1/4 dollars per share.  Find the net change under these assumptions.

15.  A parking lot has a perimeter of 78 meters.  If one side is 3 meters
     longer than the other, what are the dimensions of the parking lot?

16.  Factor out common factors:  v w - 4v w + 3v w  .

17.  Simplify the fraction q r /-26q r  .

18.  Determine p - q if p = -34 and q = -82  .

19.  How much is x(y + z) if x = 72 , y = 15 and z = -82  ?

20.  Find u if 3/u + 4 = 9/10  .
```

Computer generated answers to the quiz displayed as the previous illustration.



```
                                             ANSWERS

 1.  18n - 7
 2.  49 a  -  4b
 3.  k  =  -7.4
 4.  -5m   -  3  with remainder  4
 5.  1/729
 6.  30.6 miles per hour,  K = 5/3 M
 7.  n  =  3/5  .
 8.  (7b  +  c)/(b  - 4b c)
 9.  c  =  -8  , d  =  6  .
10.  -3
11.  -11/12
12.  29/3
13.  9qr  - 7q r  +  9qr
14.  -3 5/8 dollars
15.  18 meters by 21 meters
16.  v w (v  - 4v w  +  3w)
17.  (-1/26) q r
18.  48
19.  -4824
20.  u  =  -30/31  .
```

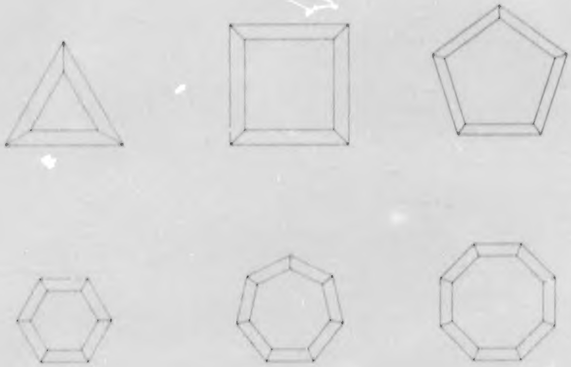
Computer generated chemistry problem set — E.E. Goldberg, M.P. Barnett and M.E. Augenstine, Brooklyn College, 1980. This is part of the output of a preliminary program that produced an extensive set of problems in introductory chemistry, from simple specifications of the different sentence structures that were needed. This is also part of the NSF funded Brooklyn College CAUSE project.

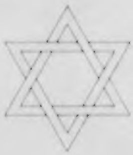


```
     Chemistry Problem Set                                  page  1


     1.  Consider the (possibly unbalanced) equation

                         MgCO3  -->  MgO + CO2

     The  volume  of  gaseous  product,  collected  over  water,  at a
     barometric pressure of 780 torr  and a temperature of 21  degrees
     Celsius  is  2.80  liters.  Calculate  the  number  of  moles of
     starting material.

     Answer:   0.116 mole.


     2.  Consider the (possibly unbalanced) equation

                         CaCO3  -->  CaO + CO2

     The  volume  of  gaseous  product,  collected  over  water,  at a
     barometric pressure of 770 torr  and a temperature of 21  degrees
     Celsius is 0.60 liter.  Calculate the number of moles of starting
     material.

     Answer:   0.0246 mole.


     3.  Consider the (possibly unbalanced) equation

                         H2O2  -->  H2O + O2

     The quantity of  the gaseous product  is 0.0075 mole.   Calculate
     the mass of starting material.

     Answer:   0.510 gram.


     4.  Consider the thermal  decomposition of CaCO3.  The  volume of
     gaseous product, collected over  water, at a barometric  pressure
     of  700  torr  and  a  temperature  of 20 degrees Celsius is 0.60
     liter.  Calculate the number of moles of starting material.

     Answer:   0.0224 mole.


     5.  Consider the thermal decomposition of MgCO3.  The mass of the
     starting material, of which 4.6% is an inert impurity, is  0.700
     gram.  Calculate  the  pressure  of  the  gaseous  product which
     occupies 8.50 liters at a temperature of 24 degrees Celsius.

     Answer:   17.3 torr.
```

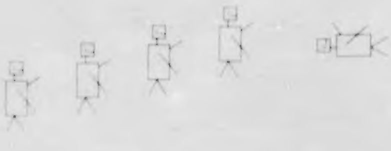
Simple figures defined geometrically and typeset on a Videocomp, to illustrate the Constructive Geometric Composition Language (CGCL) of M.P. Barnett and B.H. Barnett (2).

Vertical Views of Truncated Pyramids





An Example of Three Fold Symmetry



Translation and Deadly Rotation

Computer typeset diagrams, produced on a Videocomp with text and symbolic matter in place. The Videocomp was driven by data produced from a mixture of text and geometrical definitions of the diagrams, by a precursor of the programs described in (2). (M. P. Barnett & B. H. Barnett, 1979)

A SINE CURVE FOLLOWS

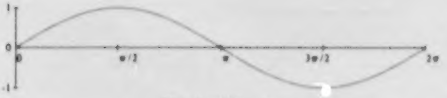
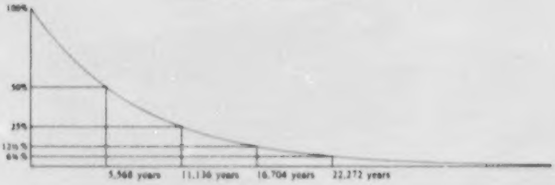


Figure 1. $y = \sin\theta$

EXPONENTIAL DECAY EXAMPLE



The radioactive decay of C^{14} follows an exponential curve $y = ae^{-kt}$. The amount of a sample halves in the time $k^{-1}\ln 2$

Computer typeset chemical information, containing text, formulas and diagrams, produced on a Videocomp in a single run, without need to cut and paste, using the TYPIC system (2).

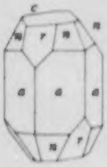
CORUNDUM

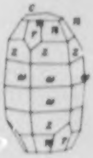
CHEMICAL COMPOSITION

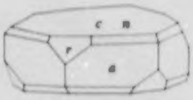
Aluminium oxide, Al_2O_3. Composition, Al = 52·91 per cent, O = 47·09 per cent. Minor amounts of Fe and Ti may be present. Cr occurs in ruby, and Fe and Ti in sapphire. Corundum may be produced artificially by heating alumina (from bauxite) in an electric furnace to between 5,000°C and 6,000°C. Artificial alumina gemstones are produced by melting Al_2O_3 in the inverted Verneuil blowpipe so as to produce pear-like drops or rods. A similar process is also used to produce industrial corundum for instrument bearings, etc.

CRYSTALLOGRAPHY

Hexagonal—*R*; Scalenohedral—$\bar{3}\,2/m$. $a : c = 1 : 3{\cdot}1638$. Crystals are usually prismatic or tapering hexagonal pyramids or barrel-shaped in habit. Twinning common on *r*$(10\bar{1}1)$; usually lamellar and polysynthetic producing striae on *c* and *r*. Also occurs massive granular.







Forms

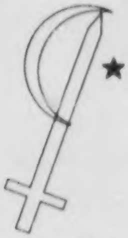
c(0001)	*n*(2243)
a(1120)	*z*(2241)
r(1011)	*ω*(14·14·28·3)

PHYSICAL PROPERTIES

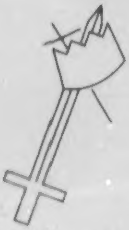
Hardness, 9. ***Specific gravity***, 4·022 but ranging between 4·0 and 4·1. ***Lustre***, adamantine to vitreous; sometimes pearly on (0001). ***Colour***, variable, giving rise to different varieties in gem qualities. ***Streak***, colourless. ***Diaphaneity***, transparent in gem varieties; other kinds transparent on thin edges or pieces. ***Fracture***, uneven to conchoidal. ***Cleavage***, none. ***Tenacity***, brittle; tough when compact. ***Fusibility***, infusible. ***Parting***, basal *c*(0001) and rhombohedral *r*$(10\bar{1}1)$.

Computer typeset maps — Videocomp output from the CGCL system (2).

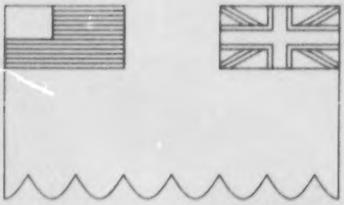
Motifs for a History course catalog, typeset on a Videocomp from geometrical definitions — Gabrielle R. Barnett, 1979.



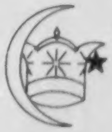
The Crusades



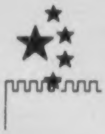
Church and State



Transatlantic Relations



Iran

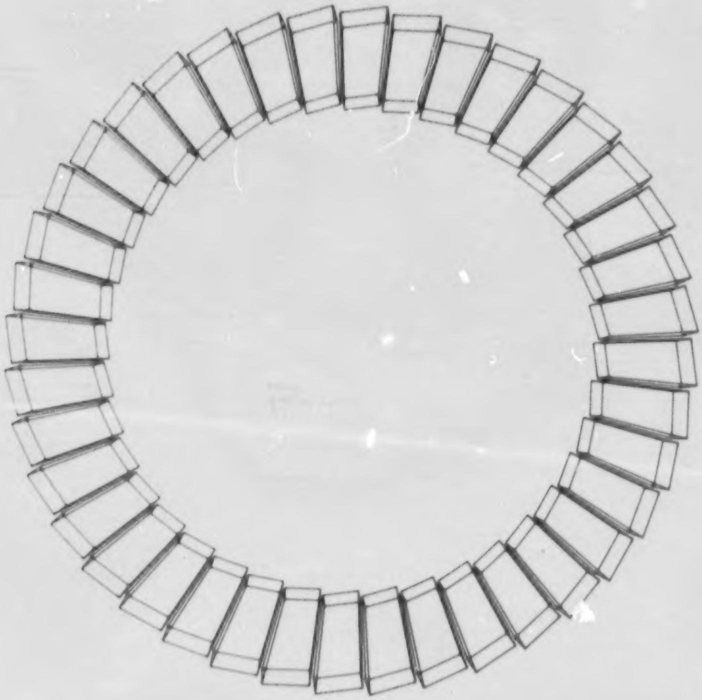


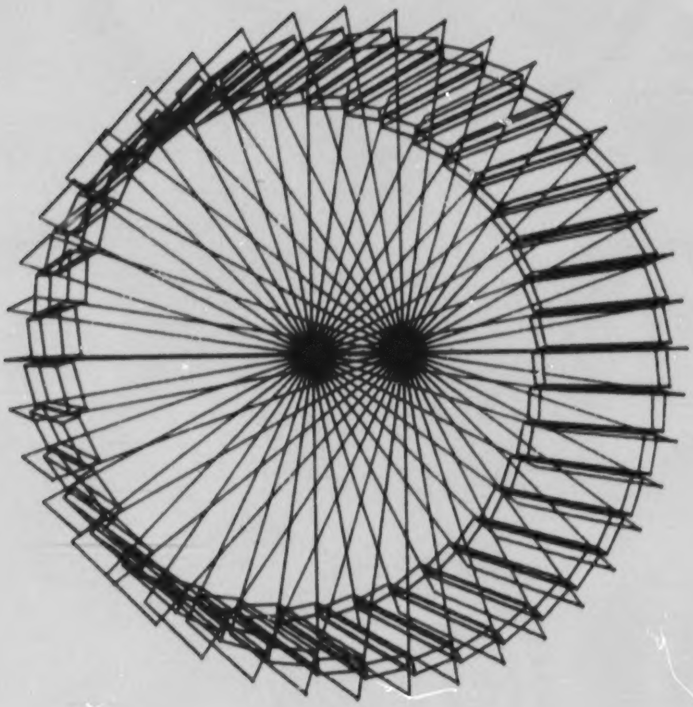
China

Shaped text — an example of the design and use of formatting algorithms, using the PAGE 2 language for the Videocomp — Gabrielle R. Barnett, 1980.

-Will you walk a little faster?- said a whiting to a snail.
-There's a porpoise close behind us, and he's treading on my tail. See
how eagerly the lobsters and the turtles all advance! They are waiting on the
shingle — will you come and join the dance? Will you, won't you, will you, won't you,
will join the dance? Will you, won't you, will you, won't you, won't you join the dance? -You
really have no notion how delightful it will be, When they take us up and throw us, with the lobsters,
out to sea! But the snail replied -Too far, too far!- and gave a look askance— Said he thanked the whiting
kindly, but he would not join the dance. Would not, could not, would not, could not, would not join the dance.
Would not, could not, would not, could not, could not join the dance. -What matters it how far we go?- his scaly
friend replied. -There is another shore, you know, upon the other side. The further off from England the nearer is to
France— Then turn not pale, beloved snail, but come and join the dance. Will you, won't you, will you, won't you, will you
join the dance? Will you, won't you, will you, won't you, won't you join the dance?- 'Twas brillig, and the slithy toves Did
gyre and gimble in the wabe; All mimsy were the borogoves, And the mome raths outgrabe Beware the Jabberwock, my son!
The jaws that bite, the claws that catch! Beware the Jubjub bird, and shun The frumious Bandersnatch!- He took his vorpal sword
in hand; Long time the manxome foe he sought— So rested he by the Tumtum tree, And stood awhile in thought. And as in uffish
thought he stood, The Jabberwock, with eyes of flame, Came whiffling through the tulgey wood, And burbled as it came! One, two! One,
two! And through and through The vorpal blade went snicker-snack! He left it dead, and with its head He went galumphing back. -And
hast thou slain the Jabberwock? Come to my arms, my beamish boy! O frabjous day! Callooh! Callay!- He chortled in his joy. 'Twas
brillig, and the slithy toves Did gyre and gimble in the wabe, All mimsy were the borogoves, And the mome raths outgrabe. The sun was
shining on the sea, Shining with all his might: He did his very best to make The billows smooth and bright— And this was odd, because it was
The middle of the night. The moon was shining sulkily, Because she thought the sun Had got no business to be there After the day was done—
-Its very rude of him,- she said, -To come and spoil the fun!- The sea was wet as wet could be, The sands were dry as dry. You could not see
a cloud, because No cloud was in the sky: No birds were flying overhead— There were no birds to fly. The Walrus and the Carpenter Were
walking close at hand They wept like anything to see Such quantities of sand: -If this were only cleared away,- They said, -it *would* be grand!-
-If seven maids with seven mops Swept it for half a year, Do you suppose,- the Walrus said, -That they could get it clear?- -I doubt it,- said
the Carpenter, And shed a bitter tear. -O oysters come and walk with us!- The Walrus did beseech. -A pleasant walk a pleasant talk, Along
the briny beach: We cannot do without more than four, To give a hand to each.- The eldest Oyster looked at him, But never a word he said:
The eldest Oyster winked his eye, And shook his heavy head— Meaning to say he did not choose To leave the oyster-bed. But four young
Oysters hurried up, All eager for the treat: Their coats were brushed, their faces washed, Their shoes were clean and neat — And this
was odd, because, you know, They hadn't any feet. Four other Oysters followed them, And yet another four, And thick and fast
theycame at last, And more, and more, and more — All hopping through the frothy waves, And scrambling to the shore. The Walrus
and the Carpenter Walked on, a mile or so, And then they rested on a rock Conveniently low: And all the little Oysters stood
And waited in a row. - The time has come,- the Walrus said, -To talk of many things: Of shoes — and ships — and sealing-wax
— Of cabbages — and kings — And why the sea is boilinghot — And whether pigs have wings.- -But wait a bit,- the
Oysters cried, -Before we have our chat, For some of us are out of breath, And all of us are fat!- -No hurry!- said the
Carpenter. They thanked him much for that. -A loaf of bread,- the Walrus said, -Is what we chiefly need: Pepper
and vinegar besides Are very good indeed — Now if you're ready, Oysters dear, We can begin to feed.- -But
not on us,- the Oysters cried, Turning a little blue. -After such kindness, that would be A dismal thing
to do!- -The night is fine,- the Walrus said. -Do you admire the view? -It was so kind of you to come!
And you are very nice!- The Carpenter said nothing but -Cut us another slice: I wish you were
not quite so deaf — I've had to ask you twice!- -It seems a shame,- the Walrus said,
-To play them such a trick, After we've brought them out so far, And made
them trot so quick!- The Carpenter said nothing but -The butter's
spread too thick!- -I weep for you,- the Walrus said: -I

Computer Graphics in artistic design: Vertical projection of The Mycanae Circle of Richard Navin, and a variation of the basic theme produced by Robert Perlberg and Valerie Bilder (Brooklyn College computer science majors). The projection appears in Richard Navin: The Mycanae Circle. Exhibition Catalog, published by The Solomon R. Guggenheim Foundation, New York, 1981. This work illustrates the introduction of artistic design in computer science educatin, as part of the Brooklyn College NSF funded CAUSE project.





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10

Personalizing Student Recruitment and Enrollment Processes Through Technology

William M. Goodwin, University of Miami

It isn't very difficult to convince most people that computers are much better than humans in additon, subtraction and a multitude of other numerical operations. But these same people may have very negative feelings towards computer interaction with humans. To these people, the idea of dealing with a computer is one that is painful, impersonal, and dehumanizing. After all, people aren't data and shouldn't be treated as such!

People want to be treated as individuals. They want information and services which are relevant to them. When we take the time and effort to provide information which is specific to our clients, customers, or students and provide services which are relevant to people as individuals, we call that effort "personalization." Personalization is more than a hand shake and a smile; it is one person showing another that he or she cares. We show people we care by treating them as individuals, by taking the time to determine their special needs and interests, and by responding or acting upon their special needs and interests.

We all know that new college freshmen are endangered species in the 1980's. In order to avoid the same fate, the University of Miami is attempting to personalize interaction with prospective students. And we are using "computers" to do it.

In the past, when we wanted to personalize correspondence with prospective students, we would try to find out something about the interests of the students, and then make sure that we included something about that in our letter. Thus, we would emphasize our offerings in Marine Biology or our Engineering School to students who had indicated that they were interested in Biology or Engineering. The people who wrote these letters, tended to say the same thing to every student interested in a particular subject. They soon found that they could be more productive by telling their secretary, "Send the Engineering Letter to John Doe" or, "Send the Biology Letter to Cathy Campus."

Through the use of word processors, the persons responsible for writing letters to prospective students can be even more productive. Once the word processor knows what to type, it can do it with amazing speed. Our System 6 with a jet spray printer can type 660 words per minute.

The College Board Student Search Service provides the names and addresses of prospective college students to university admissions offices. A college or university admissions officer can call the College Board and say, "We are interested in recruiting high school seniors whose combined SAT scores were above 1200, and who are interested in Marine Biology as a major." To these students we send a letter which describes our offerings in Marine Biology and indicates how very much we want them to apply to the University of Miami. One can select mailing lists from the College Board based on geographical location, race, SAT scores, Achievement scores, high school grades in physical science, number of years of course work in foreign languages, and whether or not English is their best language. For each of these selection criteria, there is specific information relevant to students within a selected group. Through the effective use of College Board's Student Search Service, we can be sure that relevant information gets to those students who are interested in it.

Of course we tell the computer what information has been sent to whom. By doing follow-up studies, we can analyze the marketing value of the letters we have sent and of our selection criteria.

When we add the power of the computer to the power of the word processor, we find that we can get much more personal, much faster. For example, the University of Miami receives in excess of 12,000 College Board score reports every year. Many of these score reports arrive from students who have not submitted a complete application. If a student has good SAT scores and good grades in high school, you don't need a human to decide that he should be sent a letter telling him what we have to offer. In this situation, the computer can tell the word processor to send Johnny Jones the biology letter much more quickly and efficiently than the human can. If we have not received an application from that student, the letter can be in the mail two days after we receive his score reports. And this is not a "Dear Student" letter. It starts, "Dear Sally," and tells Sally that we received her ATP score report and after reading it, we feel we have a lot to offer her. Here again, through follow-up studies we can analyze the effectiveness of each type of mailing and, based on data, take action to enhance those that work, and improve those that don't.

Admissions officers sometimes worry that the student will know the letter is computer generated and will just throw it away. However, experience with systems like PLATO have shown us that students can and do appreciate the benefits of technology when that technology helps to serve their needs. Admissions officers should look carefully at the letters received from students. After all, the Apple II personal computer has an excellent word processing program and it makes a very nice graduation gift.

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How Student Recruitment, Admissions and Enrollment Processes Can Be Improved Through Technology

Dr. Bruce T. Shutt, University of Georgia

Historical Perspective

Any one who had been involved in student records in the 60's and compared experience then with what one expects and generally receives today would truly be able to say that admissions has come a long way, baby! In the early 60's, most institutions of any size were fraught with row upon row of four-drawer file cabinets with thousands of applications literally engulfing clerks and secretaries. Individual files were missing or misplaced, and the pile of unanswered correspondence got higher each day. Often when a high school guidance counselor or parent called the admissions office to check on the status of an application, the admissions staff had to embarrassingly admit that the application could not be found. The staff would continue the search and usually within a half an hour locate it among a stack of applications that needed some particular type of service performed.

Most registration and records systems were card-oriented with the usual assortment of tab equipment including key punches, sorters, collators, reproducers, interpreters, and, yes, the 403 and 407 tab machines which were asked to do everything from sophisticated, statistical reporting to student grade reports.

Both registration and record keeping could be correctly characterized as untimely, inaccurate, and very often incomplete. In short, the registrar was hardly responsive to his constituents' needs.

Today's Technology

Today, we find admissions, registration and records officers that are operating with real-time, on-line systems. Their operations can be characterized as responsible, timely, flexible, accurate, and complete. Today's technology provides an assortment of computers that perform an infinite number of complex tasks in quick order. It includes: (1) an assortment of storage devices that allow immediate access, retrieval and update capability and (2) and assortment of telecommunication possibilities that link admissions and records officers directly with computing facilities. Most storage devices have, from the user's point of view, what appears to be an unlimited amount of storage which accommodates bulk operations in registration and admissions. The technology not only makes use of report generators, it also provides for a near explosion of information to an assortment of administrative and faculty offices almost at a moment's notice. Finally, today's technology has brought about "data bases" which allow both the user and the data processor an opportunity finally to remove the redundancy that has plagued most data processing shops since the early sixties.

Strategies for Recruitment

Today, most admissions offices have developed rather sophisticated strategies for keeping the "front door" open. Unfortunately, the recent decline or fear of decline of enrollment has forced many offices to abandon these strategies and simply go after the "warm" bodies. Nevertheless, the strategies which make use of the available technology do permit admissions offices to use search tapes such as PSAT, SAT, and ACT to provide the institution with a potential assortment of wellqualified or superior students whom the institution may wish to contact. For a nominal fee, the search files are made available to institutions which then begin a sophisticated communication dialogue with students in the hope that their offerings will be most attractive. The technology permits an admissions office to refine a strategy for securing the desired quality and quantity of students. In the past, only small institutions could afford the luxury of individual attention during the "courting" period. Today, all schools, be they private or public, small or large, have the potential for sophisticated, coordinated and complete admissions service. Today's on-line technology permits rapid loading and updating of information to be used in word processing and other systems for the purpose of securing students. One can recall in 1960 when it took as much as three to six weeks to inform a student that the office had received his application. Subsequent admissions notification came much later. Quite often, then, the applicant decided to go elsewhere. Today, a student can be told almost with the first bit of information whether or not he is eligible for admission. Once his application arrives, he can be admitted in a matter of minutes, and a letter can be forwarded to him informing him of the decision. It goes without saying that accurate, complete and timely communication goes a long way toward insuring success in meeting the enrollment goal. Accordingly, the implementation of these strategies within a college and university setting is really accomplished through identification, coordinated communication, and streamlined application processing. Almost any strategy has a chance today if one assumes that the institution is making use of today's on-line, rapid-speed technology.[1]

General Standard for Admissions Processing

Admissions processing in the 1980's will demand more personalized and coordinated communication and the use of efficient processing systems.[2] Today, students and their parents are in a buyer's market. They have institutions hounding them from the right and left with very attractive financial aid packages that make going to college all too easy. The institutions that deliver both personal and efficient service are more likely to attract students and help keep the institution's doors open. In most admissions offices today, technology provides directors of admissions with the capability of maintaining a very high standard in terms of communication and application processing. Word processing has now complemented that capability.[3] Through word processing admissions offices are now able to return a personalized letter regarding acceptance, missing information or denial quickly. It can be produced as needed and need not be a form letter off the shelf.

Admissions, Records, Financial Aid Linkage

Today's technology permits the assimilation of data in the admissions office and the concurrent use of this data by both the registrar and the director of financial aid. The financial aids office is now receiving data on tapes or diskettes about students who have applied for aid. The application data complements this information and makes it possible for the financial aids officer to provide a greatly improved service to his constituents. The admissions office is also the primary data collector for the registrar. The data file is built with the collection of application data. It is one file, not two or three. Data redundancy is greatly reduced, if not eliminated, and it is now possible for three or more offices to simultaneously use the same data.

In the 60's and early 70's, it was not uncommon for several offices to load the same data to their file. Redundancy was rampant. Later, data processing, assisted by an improved technology, helped streamline data collection and updating to the extent that data could be shared by moving data elements from one file to another — i.e., admissions data could be made available for registration and record keeping. Sometimes the data movement was uncoordinated, if not haphazard, but at least data redundancy was somewhat reduced. Today, "the file" is initiated in the admissions office, added to along the way by financial aid, housing, and records and becomes a corporate in formational entity which accommodates all. Finally, "the file" concept is truly here.

Recent Successes

There are a number of institutions that are now developing or have developed very sophisticated, totally integrated information systems that make use of a technology that was not available in the mid 60's.[4] Anything that was better than the 407/403 was considered a tremendous improvement. Little did one know what was coming. The significant improvements were to come in the 70's with the development of a technology that permitted totally integrated information systems. One can point with pride to colleagues who have been instrumental in developing these very sophisticated systems: the University of South Carolina with a data base information system that makes use of: (1) data collection at the time of admissions, (2) further refinement by financial aid, and (3) a repository of records in the records office, all in one file; Youngstown State University with a total student information system that is on-line and permits students course and section choice, not change; the University of Southern California which has recently developed a data base student information system that makes use of the very latest technology in data base design and operation; the University of Georgia where the registrar and the ADP staff have developed six or seven systems that will be part of a totally integrated student information system in the next two-to-three years. However, perhaps the best system is located at the University of Iowa, a system making use of an integrated file approach. Even though it does not use data base technology, it has probably the most up-to-date, workable student information system in the country today.

Although there is a certain amount of data redundancy in their file approach, their capability and their immediate response on the CRT's makes visitors think that this is the twenty-first century. At Iowa, all administrative systems appear to be running in an on-line environment. The Registrar, Director of Admissions and Financial Aid are happy. More importantly, the institution hasn't spent the enormous amounts of money that were predicted. All administrative users appear to be extremely pleased. The students, the faculty and the administration are being served. What more could one ask?

NOTES

1. Blandford, Robin, Bridle, Harold D. and Darling, Alexander, L., "More Time for Applicants with On-Line Admissions," *College and University*, Volume 55, Winter, 1980.
2. Chalmers, J.A., "The Effective Admissions Office," *College and University*, Volume 50, Number 4, 1975.
3. "Word Processing in the Admissions Office," *College and University*, Volume 54, Summer 1979.
4. Keller, R.E., et al., "From Admissions to Archives — A comprehensive Student Information System," *College and University*, Volume 49, Number 4, 1974.

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How Can Student Recruitment and Enrollment Processes Be Improved Using Technology?

A Small College Perspective

John P. Hine, Jr., Carlow College

Carlow College has no computer facilities on campus. Therefore, those offices which need computer services must hire service bureaus. The business office and the registrar use separate bureaus for this purpose. In Financial Aid, Carlow leases a terminal and printer linked directly to the computer of the Pennsylvania Higher Education Assistance Agency. On-line information includes not only grant and loan recipient files but also common methodology for anyone who has filed a PHEA grant application, statistical report capabilities, and letter generation.

Until recently, Carlow was using a Mag Card II to correspond with potential students. Although the quality of the letters was excellent, the production speed was not adequate to process 5000 or more inquiries on a timely basis. The problem was further complicated by the fact that in order to hold or increase enrollment level we would be forced to increase the number of inquiries to 9000 per year. The size of the inquiry file also made it difficult to maintain timely and personal contact with potential freshmen. In addition, we felt that we were not getting an adequate yield from our efforts involving the Student Search Service.

The first problem we tackled was increasing the number of inquiries. There are several companies that will provide computer based services to individualize search mailings for colleges and universities. We signed a contract with Epsilon Data Management, Inc., of Burlington, Massachusetts. Epsilon agreed to handle our search mailing for us and contracted to provide certain services. These services range from a one-time mailing of a personalized letter, to carbon copy 2nd mailings, to follow-ups of responses to these mailings. The people at Epsilon recommend that colleges follow-up their own search responses because of the amount of human intervention that is necessary.

There were several reasons Carlow chose Epsilon for this service. First, there are two former admissions people with a combined total of 16 years of admissions experience on the staff. These staff members understand the importance of timeliness and can recognize effective admissions literature. Second, Epsilon was getting results with their program. The smallest increase in responses from the previous year had been 30% and their average increase was double or triple the previous year. Carlow's increase will be from 4% in 1979 to 14% in 1980, an increase of 250%. Third, evidence indicates that the Epsilon personalized search will yield more enrolled students than a non-personalized effort. Finally, Epsilon will supply statistical reports which help the client make necessary adjustments in the criteria used to select names for search and also in the literature which is direct-mailed to the student. They will also check for and correct errors in the state and city fields of the search tape.

If a service bureau is to be used, regardless of the company selected, a contract should be signed which spells out the exact services to be provided and the dates on which any mailings are to be processed. Also, although Epsilon and other companies will provide letter and brochure writing services, the client should write these materials with guidance from the service bureau staff. Carlow found that the copy writer in Boston, even with access to our materials, was unable to capture the distinctiveness of Carlow. We learned that our view of Carlow was still the most accurate.

We then moved to our next task which was to obtain equipment that would process inquiries on a timely basis. One of our requirements was that the system be capable of providing one day turnaround of a personalized letter for 500 inquiries daily. We also needed to be able to produce mailing labels in zip code order. We investigated several word processors, and finally selected the IBM Office System 6. We also retained the Mag Card II.

Carlow chose to utilize the ink jet printer rather than the impact printer. The ink jet gave us the printing speed we needed (a one-page letter plus envelope in 50 seconds) and eliminated the requirement for continuous form paper. Because we produce letters to students from all departments on campus, continuous form paper and envelopes would have been a very expensive proposition.

In addition to producing personalized letters, the Office System 6 will generate rosters of students by high school. These rosters can be mailed to the individual high school counselors when visits to those schools are requested by our admissions counselors. We can also use the machine to match alumnae interviewers with interested students from their areas. Finally, we can sort inquiries by source which provides admissions counselors with quick access to the most productive types of inquiries in our files. During the summer, the Dean's offices will use the word processor to send personalized letters to students telling them of the events leading to their arrival on campus. All records will be analyzed by the Office of Institutional Research at various times during the year in an effort to identify our productive areas and procedures. We plan to sort our student search mailing list by zip code and area of academic interest and check it against our inquiry file to determine our productive geographic and academic interest areas. Next, we will compare our inquiry file to our applicant file and check productivity at this level. Quality of applicants will be checked here. In this manner, we hope to prune our students search file and eliminate non-production geographic areas.

The person responsible for the planning of the admissions office activities (usually the director) should learn to operate the word processor. This is the best way to learn its capabilities so that new applications can be designed.

Carlow's effort to gain access to automated services enabling use to increase the number of inquiries and service them satisfactorily was successful. This effort, however, represents only part of the ongoing admission plan. We rely heavily on personal contacts with potential students including alumni, faculty, and selected members of the administrative staff. But the services and capabilities realized from Epsilon Data Management, Inc. and the IBM equipment have freed the staff from some of the time consuming manual efforts that have enabled us to provide more personal services than in previous years.

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The Development Office and Data Processing

Allan M. Herrick, Duke University

In the various departments of higher education, one of the most difficult to computerize is the Development Office. It is almost totally a "people" business engaged in selling a product. Data proacessing can be a great marketing tool to assist in this effort, or it can be a waste of time and money. This paper is a discussion of some of the issues and policies that should be addressed before a large scale data processing system is contemplated in the development area. Duke University has just completed such an intensive study in this area and the result was the creation of detailed specifications for a new system designed to satisfy the needs of three areas: Development, Gift Records, and Alumni Affairs.

I. Issues

Before any work is begun on a new computer system it is important to resolve certain issues that would have a major impact on how it is designed. These include timeliness of the information, and determining what data elements will be captured and how the final output should appear.

To be effective, the information on any system should be available on a timely basis. Information is generally used to prepare for a prospect call, write a proposal, gather a list of potential donors for a particular project, or to prepare information for the President when he makes development calls. Twenty-four to forty-eight hours turnaround for printed reports is acceptable, but ten days is not. The information should also not be reported in a code, but written as clearly as possible in English. A CRT screen and printer can provide immediate access to information. This easy retrieval of information, however, will never take the place of reviewing the research file containing news releases, correspondence, trip reports, etc. Acquiring the data from a computer system will aid primarily in the identification process.

Development officers should be educated as to what to ask for, and more importantly, they should know what is available on the system. One Development officer should act as the interface with the computer center. A basic manual should also be prepared listing all the programs that are available with sample reports.

There are four different areas of information that are essential to any system serving a Development Office. These include: the donor's giving potential, his/her areas of interest at the institution, the connections the donor has with the institution, and a five year giving history. A major capital campaign will many times force an institution to examine what information is available on the prospects and whether the data processing system will be able to generate the necessary reports to support a campaign.

A means of measuring the effectiveness of certain mailings is essential to any Development Office as well. Targeting special groups for solicitation and monitoring the response should be incorporated into any data processing system. In addition, the ability to merge with other files and records is important. It is obvious that the coordination with the Registrar's Office is critical, but searching the files for matching gift companies and using corporate files to update employment data should also be considered.

Obviously the cost of any data processing system is important. In Duke's case, an attempt is made to keep the data processing budget at 10% of the overall budget. Efforts are made to reduce the amount of money required to raise one dollar. For our overall operation, Duke, on the average, spends six cents for each dollar raised. On a more limited scale, the Annual Giving program spends eighteen cents for each dollar raised. Budgets to sustain a good data processing system can be justified when the value merits the expense.

Finally, it is important to remember that the information on file is only as good as the input from the users. Trip reports and new biographical and financial data must be added as changes occur. It is imperative that the Development Office personnel understand their responsibility for the reliability of the data on file.

II. Policies

The most important policies to establish at the outset are who will have access to the information and who will be responsible for the maintenance of the file.

Most Development officers are quite protective of their prospects. We are judged to a large extent by the amount of money raised during a particular year, and we know that a good prospect offers our best hope of achieving our goal. It is also true that Development officers cannot operate effectively if they are denied access to certain records on a file. A security policy has to be established at the outset, covering who can enter the file and what information can be obtained. Duke has developed a security policy which allows a Development officer to secure a non-alumni prospect for a period of time, and permits a user to have only the name. In addition, the policy provides that only certain personnel can enter the file by means of a password. The file is further restricted as to who can access the development and gift history segments.

At Duke, it is more efficient to have the recording of gifts tied to the general accounting of the University to avoid double posting. This method can pose a problem when the Development Office loses a certain degree of flexibility in the way in which gifts are recorded. In Duke's System, the Development Officers may apply their own codes and references which designate the gifts in appropriate ways. This is true with private foundations, matching gifts, and memo-type gifts.

Because the process of entering new data is not an enjoyable task for Development officers and many feel that all new data will appear on the record by magic, a definite policy is necessary regarding who will be entering the data, where it will come from, and who maintains it.

Under the Duke system, there will be two input stations, the Gift Records Office and the Data Base Coordinator's Office. The Development Office will not be updating information directly through a CRT or other means. The Office of Data Base Coordinator will be a service department and not tied in a reporting way to the Alumni Office or Development Office.

Charging for data processing services can be a difficult procedure, especially if bills are made in total to the Development Office. Duke has worked out a system where each computer program that is run is charged on the basis of computer time and overhead. All development offices also have a computer maintenance item in their budget which allow them to change existing computer programs. Each department within the Development Office shares the cost of the Data Base Coordinator and his/her staff. This is done on a pro-rated basis depending on the number of records maintained on the file.

The issue of who, if anyone, owns the data in the file is another that must be addressed at the outset. It seems logical that the data on the file is a University resource and not controlled by any department or individual. This concept is sometimes difficult to put into practice, but the information is there to be shared. A single data base management system supports this theory.

III. Benefits of an Effective Data Processing System

It is often difficult to prove to the top administration officers that an investment in a good data processing system can yield positive returns. Nevertheless, figures must be produced that substantiate this theory. The following are some benefits which the team at Duke believes are gained by an effective data processing system.

The image of the University improves with the maintenance of accurate records. A correct address can help relations with a donor and recording a gift correctly is also important. Many hours can be saved by not having to answer letters which ask: why can't my address be kept current? Why is my wife's name spelled incorrectly? Why do you send four copies of every mailing.

The axiom that one cannot raise money without the proper information is true. A computer can help with this task more than anything else that is available. It was our opinion that each department in the Development Office could raise $100,000 more with the proper information on the major prospects.

At a major university many of the graduate and professional schools have their own development officers, which creates a tendency toward separation from the central staff. A good data processing system can help unify all efforts and save some embarrasing moments. Too often it appears to the prospect that the "right hand doesn't know what the left hand is doing."

Finally, it is our feeling that a good single system can be a more effective use of the University's resources. Too often the various departments or schools are forced to go out on their own to develop individual data processing systems which unfortunately do not communicate with each other.

IV. Our Approach

Once we had settled all the issues and determined the proper policies, we then set about to develop a new system that would serve Development, Gift Records, and Alumni Affairs.

The first step was to appoint three sponsors from these areas who would guide our deliberations and be responsible for their own area meeting all requirements. The next step was to appoint a working team of five people representing the primary users plus a staff member from the data management department. Our discussions followed the methodology contained in IBM's Application Transfer Team approach. The concept of this approach is to have a small group of users (those who actually input and work with the data) work closely for 10 weeks or more to design a new system that will improve their present methods. this team worked for a period of ten weeks and the assignment became their number one priority. All potential users were interviewed in the first three weeks and the remaining weeks were spent designing the system.

The final document was a conceptual design which spelled out in detail how the system would operate. Seventeen programs were identified for implementation of the system. We now were in a position to make the decision as to whether we should develop this new system in house or buy an existing package from an outside software house that meets our specifications.

This approach worked extremely well for us. We not only designed a most worthwhile system, but also gained a much better understanding of the individual departments and their dependencies on each other.

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Alumni Systems at Notre Dame

Brian Walsh, University of Notre Dame

The University of Notre Dame du Lac, located on the outskirts of South Bend, Indiana, is an independent co-educational Catholic university with an approximate enrollment of 6800 undergraduate, 1500 graduate and 500 law students. Founded in 1842, by Father Edwin Sorin C.S.C. of the French religious order known as the Congregation of Holy Cross, Notre Dame's campus has grown to become a self-sufficient, geographical entity of 1,100 acres valued in excess of $200 million. The congregation operated the University until March, 1967 when it relinquished control to a predominantly lay Board of Trustees. Notre Dame presently consists of four undergraduate colleges (Arts and Letters, Science, Engineering, Business Administration); the Law School; and a Graduate School.

Computing Center

The Computing Center provides support to both the Administrative and Academic Communities at Notre Dame. The Director of the Center, who reports to the Executive Vice President of the University, has overall responsibility for all computing activities on the campus. An Associate Director oversees administration of the center, hardware/software acquisition and maintenance, academic and administrative applications, data base administration and operations. Each of these areas is managed by an Assistant Director or Manager who reports to the Associate Director.

The Administrative Applications Group consists of a Manager, a secretary and a staff of eleven professional analysts and programmers. This group is responsible for all new Administrative program development and production support for existing systems at the University.

In addition to the Computing Center Staff, the Notre Dame Information System (NDIS) Office oversees development of a Management Information System (MIS) on the campus. Currently there are two major MIS related tasks underway at the University. A new Personnel/Payroll System (TOPPS) and a new Student System (STATIS) are underway.

New system development is monitored by the Committee on Administrative Systems Planning, and Development (CASPAD). This committee is chaired by the Dean of Administration with the following members: Director of NDIS, Data Base Administrator, and Manager of Administrative Applications.

Operating Requirements

The University has an IBM 370/168 with an internal storage capacity of 8 megabytes. The computer is under the IBM operating system (OS/VS2 Release 3.7). Peripheral hardware includes six IBM 3420 9-track tape drives, one IBM 7-track tape drive, 14 IBM 3350 disk drives, and two IBM 3330 disk drives. Data is input into the system via three IBM 3277 video terminals operating under IBM's Time Sharing Option (TSO). An IBM 6640 jet ink printer is located in the Development Office and functions as an output RJE station.

All terminal programs are written in COBOL and call PL1 programs to decode the name information on the ISAM files. These programs also call the Screen Management routines that were written in assembler by the University's software group and currently are being marketed by IBM. All other programs in the daily cycle and most of the on request system and special request reports are written using MARK IV.

Region requirements for the terminal programs are 768K. All other programs operate in a 192K region.

All jobs in the daily update cycle require about seven minutes of CPU time and about 90 minutes of elapsed time. On request jobs and MARK IV requests will generally run in about two minutes of CPU time and be in the system under 90 minutes.

With the installation of the inquiry package, the daily print requirements were greatly reduced. Currently less than 10,000 lines are printed daily. On request jobs account for about 500,000 lines of print per month. Several large on request reports are now being put on fiche.

Public Relations and Development

The mission of Notre Dame's Office of Public Relations and Development is to generate understanding of, and support for the eight professionals with a clerical staff of approximately forty and an annual budget of more than $1 million. It consists of six operating departments: Information Services, Special Projects, Development, and Notre Dame Alumni Association, Printing and Publications, and Notre Dame Magazine.

The Department of Development, with a normal complement of eight professionals, operates regional offices in New York City, Chicago, and Los Angeles, as well as on the campus. It seeks financial support for Notre Dame from the University's 60,000 alumni and from thousands of non-alumni friends, parents, corporations, and foundations. The usual vehicle for this support is the Notre Dame Annual Fund. However, since 1960 the University has conducted four capital campaigns which have generated $239 million in gifts and commitments. Approximately 50% of the alumni can be expected to participate in the Annual Fund while 80% or more contribute to the capital drives.

The recent $130 million Campaign for Notre Dame, publicly announced in April 1977 (although leadership gifts work had been underway before that), has in a little over two years surpassed its goal with pledges and gifts of $131,292,821 from 39,409 sources. The campaign has earmarked 71% of its funds for endowment, 23% for buildings, and 6% for current use. Four thousand volunteers personally solicited campaign pledges in forty-one major cities, and alumni and friends living elsewhere were contacted by direct mail.

The campaign funds are made up of the following components: $45,874,413 from alumni and other individuals except parents; $42,245,698 from parents of students; $14,562,520 from corporations; and $18,339,124 from foundations. A total of $10,271,066 is in the form of wills and bequests.

Executive Overview

The Integrated Gift System (IGS) utilizes an IBM 370/168 Central Processing Unit, with TSO/TCAM. The IBM 3277 Video Terminals are used for data entry and inquiry. The IBM 6640 Jet Ink Printer is used for typing personal acknowledgement letters and producing an immediate printout of a donor's record. The terminals and printer are located in the Development Office in the Administration Building.

Address corrections or additional gifts/pledges are entered while viewing the contents of the existing record. These input transactions are stored during the day to update the master file in a batch mode overnight. When a gift or pledge is processed a file is generated to be communicated to the IBM 6640 the following morning. The acknowledgement letters are generally in the mail by three o'clock for the previous day's transactions. The final daily step builds an ISAM file for inquiry purposes for the following day. The Master Record contains up to 380 characters of demographic information. Gift/Pledge data is maintained in a 120-character record. Graduating seniors and all parents of incoming freshmen are added to the file annually.

Controls are established at the entry point so that the daily bank deposit can be reconciled and the computer produced control can be verified the following morning. The system creates the audit trail report, input journal, daily accounting journal and gift register.

Monthly and annually the system generates all of the statistical reports required by the Unversity administration. Effective campaign-related reports also are provided from this system. Those reports were augmented by extensive use of MARK IV during the National Campaign Phase. The Alumni Office utilizes Master Record information for Alumni Club Lists, Reunion Lists, the Fifty Year Club, etc.

In summary, the system is responsive to the needs of the Development Office. It is accurate (the Development Office enters their own data). It is very personal, treating each donor as an individual and addressing him or her by the correct name. With the use of MARK IV the system is very flexible. Any report necessary to analyze any situation can generally be produced the next day, using MARK IV.

DONOR MASTER RECORD LAYOUT

The donor master record is 380 characters in length. The key is the donor identification number. All name and address fields are maintained in upper and lower case representation.

```
01 ALUMNI-DEVELOPMENT-BASIC

03  ADB-ID-NUMBER
03  FILLER
03  ADB-RECORD-TYPE
03  ADB-SKIP-CODE
03  ADB-NAME
    05 ADB-LAST-NAME
    05 ADB-FIRST-NAME
03  ADB-MARITAL-STATUS
03  ADB SEX
03  ADB-BIRTH-YEAR
03  ADB-MAILING-NAME
03  ADB-DATE-ADDRESS-CHANGE
03 05 ADB-MONTH-CHANGE
   05 ADB-YEAR-CHANGE

03  ADB-START-DATE
    05 ADB-START-YEAR
    05 ADB-START-MONTH
    05 ADB-START-DAY
03  ADB-DONORTYPE
03  ADB-POTENTIAL
03  ADB-ROGION
03  ADB-CITYCODE
03  ADB-SUBCODE
03  ADB-VIPIND
03  ADB-VIPCODE
03  ADB-SPECCODE
03  ADB-DEATHYR
03  ADA-POSCOD

03  ADB-FOLDER
03  ADB-VOLNTR
03  ADB-FRIEND-CD
03  FILLER
03  ADB-SOCONE
03  ADB-SOCTWO
03  ADB-SOCTRF
03  ADB-SOCFOR
03  ADS-CLASS-YEARS
    05 ADA-STATUS
    05 ADA-FIRST-YEAR
    05 ADA-SECOND-YEAR
    05 ADA-THIRD-YEAR
03  ADA-COLLEGE
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03 ADB-STREET                   03  ADA-JOBCOD              03  ADA-MAJORS.
    05 ADB-STREET-4             03  ADA-SPOUSES-NAME            05 ADA-FIRST-MAJOR
    05 ADB-FILLER               03  ADA-CROSS-REF               05 ADA-SEC.-MAJOR
03  ADB-CITY-STATE              03  ADA-NICK-NAME               05 ADA-THIRD-MAJOR
03  ADB-STATE-CODE              03  ADA-STUNAM1             03  ADA-DEGREES
03  ADB-ZIP-CODE                03  ADA-STUYR1                  05 ADA-FIRST-DEG.
    05 ADB-ZIP-AREA             03  ADA STUNAM2                 05 ADA-SECOND-DEG.
        07 ADB-POS1-ZIP-CODE    03  ADA STUNAM3                 05 ADA-THIRD-DEG.
        07 FILLER               03  ADA-STUYR3              03  ADA-AFFILIATIONS
    05 FILLER                   03  ADA-STUNAM4                 05 ADA-HONORARY
03  ADB-COUNTRY                 03  ADA-STUYR4              03  ADA-CORP-LINE-1
03  ADB-TELEPHONE-NO.           03  ADB-DONOR-RPT-FLAG      03  ADA-CORP-LINE-3
    05 ADB-PHONE-3                                          03  ADA-SOC.-SEC.-NO
    05 ADB-PHONE-4                                          03  ADA-MAINDNME
                                                                05 ADA-NMEMAID
                                                            03  FILLER
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PLEDGE MASTER RECORD LAYOUT

The pledge master record is 120 characters in length and is shown below. The key to the record is the donor identification number and the account number. There can be any number of pledge records to each donor record but only one record per account restriction.

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                        01 ALUMNI-DEVELOPMENT-PLEDGE

03  ADP-ID-NUMBER               03  ADP-PLEDGE-AMOUNT       03  ADP-ST[illegible]-CODE
03  ADP-SC12-CODE               03  ADP-PAYMENT-AMOUNT          05 ADP-RE[illegible]
03  ADP-ACCOUNT-NO.             03  ADP-PAYMENT-DUE             05 ADP-CITYCO[illegible]
    05 ADP-ACCT-NO              03  ADP-REMINDER-CODE           05 ADP-SUBCODE
    05 ADP-ACCT-OBJ             03  ADP-PLEDGE-DATE         03  ADP-CONTACT-PGM
03  ADP-RECORD-TYPE                 05 ADP-PLEDGE-YEAR      03  ADP-DONOR-CODE
03  ADP-DTE-PL-MADE.                05 ADP-PLEDGE-MONTH     03  ADP-ACK-CODE
    05 ADP-DTE-PL-MADE-YEAR         05 ADP-PLEDGE-DAY       03  ADP-REMARKS
    05 ADP-DTE-PL-MADE-MONTH    03  ADP-ACCT-DESC           03  FILLER
    05 ADP-DTE-PL-MADE-DAY      03  ADP-ACCT-FINAL-SIX
```

RECEIPT MASTER RECORD LAYOUT

The receipt master record contains 120 characters and is shown below. The key to the record is the donor identification number, the General Ledger account number, and the transaction date. A donor record can have any number of receipt records. The Update program will add together input receipt records with the same key. A common code structure between the pledge and receipt records permit pledge payments to be matched up to the correct pledge record.

```
                        01  ALUMNI-DEVELOPMENT-RECEIPT


03  ADR-ID-NUMBER         03  ADR-DATE                  03  ADR-DONOR-TYPE CD
03  ADR-SC12-CODE             05 ADR-YEAR               03  ADR-PYMT-TYPE CODE
03  ADR-ACCOUNT-NO            05 ADR-MONTH              03  ADR-AMOUNT
    05 ADR-ACCT-NO            05 ADR-DAY                03  ADR-ACCT-DESC
    05 ADR-ACCT-OBJ       03  ADR-GIFT-ACK              03  ADR-FIN-SIX
03  ADR-RECORD-TYPE       03  ADR-GIFT-DESCRIPTION      03  ADR-STRUC-CODE
                              05 ADR-GIFT-REMARK            05 ADR-REGION
                          03  ADR-CONTACT-PROG-CD           05 ADR-CITY-CODE
                                                            05 ADR-SUB-CODE
                                                        03  FILLER
```

Other Files

Other files used in the IGS system are listed below.

- Business Master file is a 120-character record containing the business address for a donor. This sub-system file is maintained using MARK IV.
- Alumni Club Name file contains the name of each Alumni club and the range of zip codes which make up each alumni club. This file is maintained by the Admissions Office.
- MIS Table File is maintained by the NDIS Office and is updated by entries originating in the user offices. This file is used by the IGS System to validate all coded fields, and to

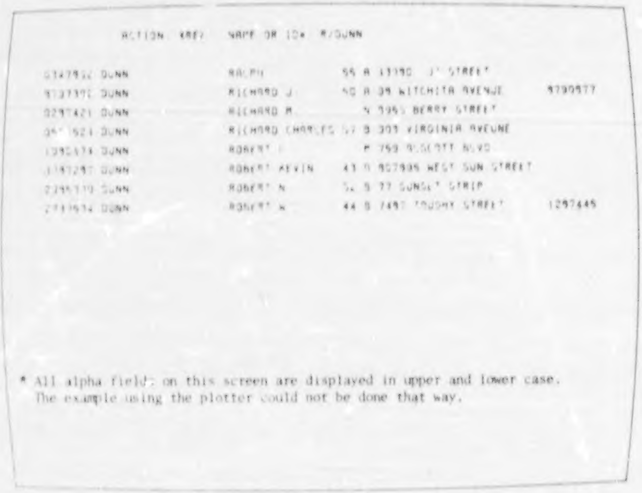
provide descriptions of coded data on all reports and inquiry screens.

SYSTEMS INQUIRY/INPUT/OUTPUT

INQUIRY

The terminal programs retrieve data using two ISAM files. All terminal processing begins with a screen with two tags and two input fields. They are ACTION: and NAME OR ID#:.

XREF is the action code that accesses the cross reference file. The program accepts a name entered in the NAME OR ID# field according to the rules established (e.g. R/Dunn) and searches the Name/ID number cross reference file using this key. **All** names equal to the original or altered search key are displayed on the terminal in the manner shown below.

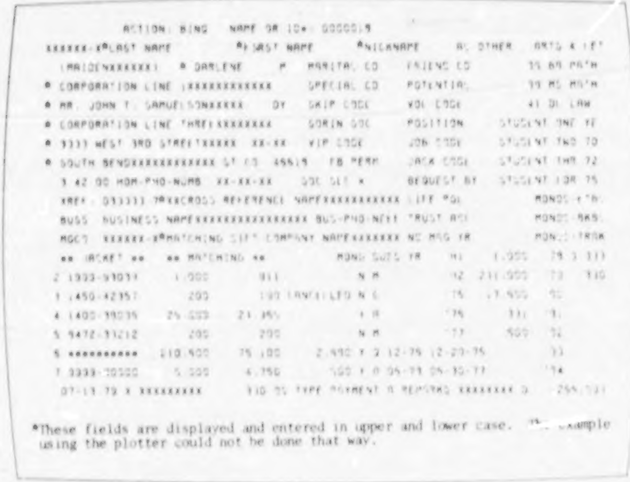


```
            ACTION: XREF   NAME OR ID#: R/DUNN

0147952 DUNN            RALPH            55 A 13390 J STREET
9137391 DUNN            RICHARD J.       50 A 39 WITCHITA AVENUE      9790977
0297421 DUNN            RICHARD M.          N 5965 BERRY STREET
0571521 DUNN            RICHARD CHARLES  57 B 303 VIRGINIA AVENUE
1390174 DUNN            ROBERT F.           P 759 ALCOTT BLVD
3181297 DUNN            ROBERT KEVIN     43 D 907895 WEST SUN STREET
2295110 DUNN            ROBERT N.        54 S 77 SUNSET STRIP
2711574 DUNN            ROBERT W.        44 B 7497 TOUHY STREET       1297445
```

* All alpha fields on this screen are displayed in upper and lower case.
The example using the plotter could not be done that way.

BINQ is the action code for the basic inquiry. If an identification number is entered in the NAME OR ID# field, the program searches the primary data file for the number entered. If a name was entered, the program to search the XREF file is invoked. If a record is found on the XREF file that uniquely matches the name as it was entered, its identification number is passed back to the driver program and used as the search key for the primary data file. The record is then displayed on the terminal as shown below. If a match is not found on the XREF file on the first search, the search key is altered and another search is made. When this happens, names that match the modified search key are displayed on the terminal as shown on the previous page.



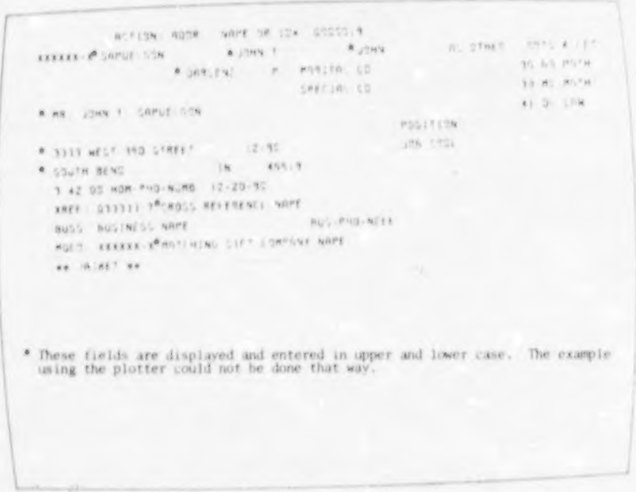
```
          ACTION: BINQ   NAME OR ID#: 0000019
XXXXXX-X*LAST NAME         *FIRST NAME      *NICKNAME      AL OTHER   ARTS & LET
 (MAIDENXXXXXXX)   * DARLENE     M   MARITAL CD    FRIEND CD         35 AB MATH
* CORPORATION LINE 1XXXXXXXXXXXX     SPECIAL CD    POTENTIAL         39 MS MATH
* MR. JOHN T. SAMUELSONXXXXX    DY   SKIP CODE     VOL CODE          41 DL LAW
* CORPORATION LINE THREEXXXXXXXX     SORIN SOC     POSITION      STUDENT ONE YE
* 3333 WEST 3RD STREETXXXXX  XX-XX   VIP CODE      JOB CODE      STUDENT TWO 70
* SOUTH BENDXXXXXXXXXXXXX ST CD  46619   FB PERM   JACK CODE     STUDENT THR 72
 3 42 00 HOM-PHO-NUMB  XX-XX-XX    SOC SET X      REQUEST BY    STUDENT FOR 75
 XREF: 033333 7*XXCROSS REFERENCE NAMEXXXXXXXXXXXX LIFE POL           MONDS-ETH
 BUSS  BUSINESS NAMEXXXXXXXXXXXXXXXXX BUS-PHO-NEXT TRUST ACT          MONDS-BAS
 MGCT  XXXXXX-X*MATCHING GIFT COMPANY NAMEXXXXXXX NC MSG YR           MONDS-TRAN
 ** JACKET **   ** MATCHING **            MONG SUCS YR    HI    1,000   79 3 333
2 1933-93033     1,000       911              N M          92  211,000   73   330
3 1450-42357       200       100 CANCELLED N C             75   17,500   90
4 1400-39035   25,000    21,355              Y R           75      333   91
5 9472-33212       200       200              N M          77      500   92
6 **********  210,500    75,100      2,990 Y 3 12-75 12-20-75             93
7 3333-20000     5,000     4,750       500 Y 0 05-73 05-30-77            94
 07-13-79 X XXXXXXXXX      310 35 TYPE PAYMENT 0 REMSTRG XXXXXXXX 3    255,333
```

*These fields are displayed and entered in upper and lower case. The example using the plotter could not be done that way.

INPUT

All input is entered on IBM 3277 terminals by the Development Office personnel. There are two primary screens that are used: the address screen explained below and the gift screen explained on the next page. Both of thse screens create transactions to update certain fields on Master file records. Several other screens permit changing any information on the Donor Master and most of the fields on records in the other files. A special screen is used to add new donors to the master file.

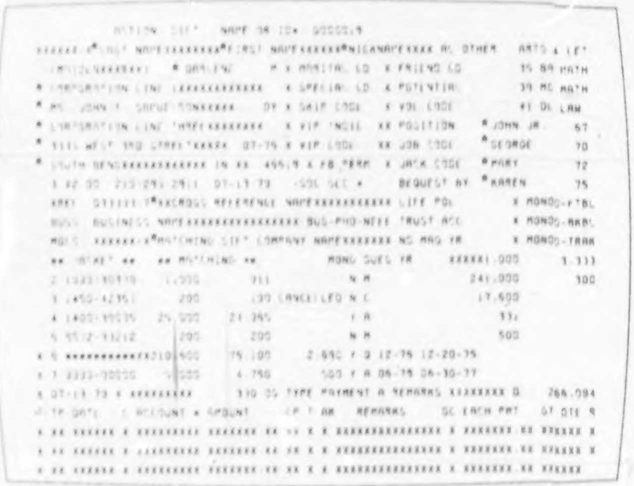
ADDR is the action code used for inputting address changes. Some fields are 'display only' and can not be changed. The search using the NAME OR ID# field is the same as that described under the BINQ Action code. If any of the displayed data is changed, the new data is edited. If correct, a transaction is created for input to the next Master File update. If incorrect, the field(s) in error will be highlighted (double intensity).



```
          ACTION: ADDR   NAME OR ID#  [illegible]
XXXXXX-*SAPUTSON        *JOHN T        *JOHN        AL OTHER  [illegible]
                  *DARLENE     F   MARITAL CD                 35 AB MATH
                                   SPECIAL CD                 33 MS MATH
                                                              41 JD LAW
*MR. JOHN T. SAPUTSON
                                                  POSITION
*3333 WEST 3RD STREET        12-9C                JOB CODE
*SOUTH BEND              IN    [illegible]
 3 42 05 HOM-PHO-NUMB  12-20-9C
 XREF: 033333 T*CROSS REFERENCE NAME
 BUSS: BUSINESS NAME                  BUS-PHO-NEXX
 MGFT: XXXXXX-X*MATCHING GIFT COMPANY NAME
 ** [illegible] **
```

* These fields are displayed and entered in upper and lower case. The example using the plotter could not be done that way.

GIFT is the action code that is used to post all types of gifts, new pledges and pledge payments. Additionally, the address fields displayed can also be changed. The search using the NAME OR ID# field is the same as the BINQ Action code previously explained. The last three lines of the screen are input areas for any combination of gifts and pledges. As an example, a new pledge and a cash gift restricted to two different ledger numbers could be entered in one transmission. At the same time a corrected address could be entered. Pledge payments could in most cases be posted with a single keystroke.



*These fields are displayed and entered in upper and lower case. The example using the plotter could not be done that way.

OUTPUT

Files:

— Four generations are maintained for the Master file, the, the Business Master File, the Daily Input Transaction File, and the Daily Report File. The daily merged transactions file is also kept on a Monthly Transaction File to be used with the monthly backed up Master File to recover the files in the event of a disaster.

— A file is generated in each update run that contains acknowledgement letter information that is transmitted to magnetic cards at the IBM 6640 printer. The file is in letter number/donor name sequence. Each letter type is recorded on a different magnetic card. There is a wide variety of letters, each tailored to a specific situation. Letters (and envelopes) are printed on the IBM 6640 by merging the computer information with a 'standard' letter body.

Reports (immediate):

— **Donor Record Print.** Using the Action Code PRT2, the Development Office can request an immediate print of any donor's information. The output is internally directed to the IBM 6640 located in their office and it must be requested by transmitting a 'receive' card to the central computer. An example of the Donor Record Print appears on page 196.

Reports (daily):

— **Transaction Listing.** Sequence is by Donor identification number. This is an IEBGENER listing of the sorted/merged TSO data set transaction files used to verify HOW and/or IF a transaction was entered on the terminal.

— **Daily Input Journal.** Sequence is by Donor identification number. This is a control report and a listing of today's transactions for gifts and pledges. All entries (add, change, delete) are shown that affect either type of record. The final page of the report shows a number of totals used to maintain control of the computer files.

- **Daily Accounting Journal.** Sequence is by General ledger account number. This is a listing of all entries affecting the general ledger. A total is shown each time the account number changes. These totals are used by the accounting office to prepare manual journal entries. They also verify the bank deposit with figures shown on the summary page.
- **Daily Control Report.** A Single page report that shows the totals from the old master file, today's transactions, and the total of the new master file. Control is maintained for total donor records, the number and dollar amount for all pledges, and the number and dollar amount for all gift records. These figures are used to verify the manual controls that are maintained daily in the Development Office.
- **Letter Listing.** Sequence: Letter number then donor name. This report is used to verify the letters produced on the IBM 6640 printer. It also is used to determine if a letter was sent, the type sent and the date prepared if a question should arise. It is printed in upper and lower case.
- **Daily Audit Trail.** Sequence: Donor Identification number **and** alpabetical on donor name. It is used in the daily balancing and error correction process and also serves as a permanent audit trail of all transactions. Today's report (for donor records with activity) will show the date of previous activity. That Audit Trail will show the previous activity date. Using this methods, all transactions activity for a donor could be located. The alpha list is used in the inspection process.
- **Daily Gift Register.** Sequence: Region number then donor name. Six copies are printed. One copy functions as a permanent record of today's gifts. The other five copies are distributed to the Regional Directors. The Regional Directors review the report looking for large gifts or familiar names so that they may also add their personal thanks to the donor.

- **Daily Acknowledgement Receipt.** Sequence: Region number then donor name. The report is a preprinted form produced in four parts in upper and lower case. One part is sent to the regional office for their files and for use in the inspection process. The original copy becomes a part of the permanent files in the Development Office.
- **Master Record Print.** Sequence: Donor Identification number. This is a **detailed** listing of **all** information in the IGS Master File for a donor. It is requested through the terminal inquiry system, using Action Code PRT1. It is used for preparating input using information that can not be obtained from the GIFT screen. Also all adjustments to existing gift or pledge records are done referring to the master record print.

Reports (on request):

- **Master File Alpha List.** Sequence: Donor name. This is an alphabetical listing of the entire master file. The output it also put on microfiche and each regional office receives a copy. The listing shows complete name and address information.
- **Master File Identification Number List.** Sequence: Donor identification number. This report contains the same information as the previous report, but it is not put on fiche.
- **Contact Code Summary.** Sequence: Primary source then contact code. This report shows the current period and fiscal year-to-date statistics for the source of gifts (e.g. direct mail, personal contact, etc).
- **Annual Reports.** Sequence: Each report in the set is different. This job summarizes the annual statistics on ten different type reports. These are: Large Donor Report, Giving Range Summary, Primary City Report, Summary by Region, Summary by Donor Type, By State Report, Class Year Report, Corporation List (all), Match-

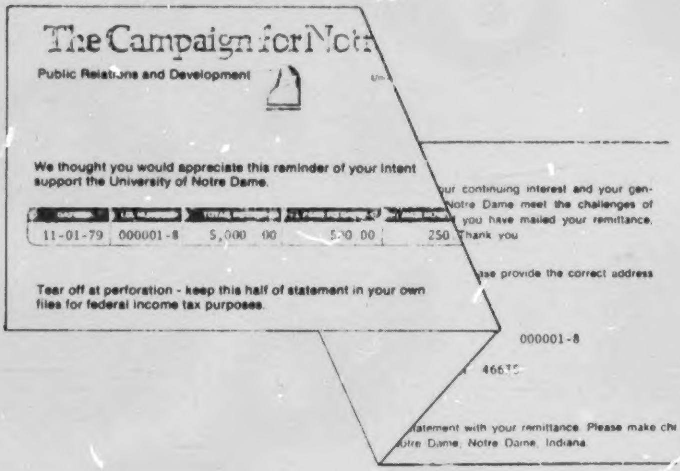
ing Gift Report, Regional Corporation/Foundation Report.

- **Component Report.** Sequence: Created component sort key. This report summarizes the actual campaign progress by major/minor component element and calculates a percent of the quota that has been achieved.
- **Pledge Reminders.** Sequence: Donor name. This job creates the pledge reminder statement shown on page 195 and several different reports. One listing shows the donors that had a reminder statement produced. Additionally, a regional past due list is printed. Another option is to print a listing of all donors who have a pledge record.
- **Expected Pledge Income Report.** Sequence: Donor name. This job, through a control card option, can calculate the yearly income to be expected from pledges for an individual ledger restriction, a range of ledger numbers, or all pledges regardless of restriction. Each donor pledge record is spread over the remaining part of the current year, the next four years, and one figure representing the remainder. In the summary report, the yearly spread covers the remaining current year plus the next nine years.
- **Maiden Name Report.** Sequence: Maiden name. Married alumnae information is printed and serves as a cross reference list.
- **Football Application List.** Sequence: Donor name. Alumni who have contributed the required amount are listed and mailing labels are printed.
- **Notre Dame Magazine Labels.** Sequence: Country then zip code.
- **Special Annual Accounting Report.** Sequence: Request number then donor name. This report was designed to extract and list all 'gifts in kind' and separately list all general use gifts exceeding a dollar amount specified by the accounting office.

- **Campaign Progress Report.** Sequence: Request number then donor name. This report shows the progress in a major city within a time span specified in the control card.
- **Reunion Class List and Labels.** Sequence: Class year then donor name. The class list is reproduced to provide a roster to each member of the class. The labels are used to mail out invitations to attend the class reunion.
- **Prospect Cards.** Sequence: Major city then potential type. Individual volunteers are given a group of these cards and they are used as a source of information for telephoning or personal calls. They provide a very important tool in the solicitation process. An example is on page 195.
- **Prospect List.** Sequence: Same as Prospect Cards. The Prospect List is used by a team or area volunteer captain. It is a worksheet type report designed to assist in monitoring the solicitation activities in an area or group.
- **CFAE Report.** Sequence: As needed for the pre-printed report. This is an annual report to the Council for Financial Aid to Education (CFAE).
- **Campaign Progress Report.** Sequence: Various. The report in total consists of these individual reports: the Large Donor Listing, Giving Range Summary, Regional Report, Regional Summary, Donor Summary.
- **Alumni Club List/Labels.** Sequence: Variable depending on the control card information. Selection is by Alumni Club number which is not part of the master file data. The Alumni Club number zip code cross reference file is used. The output can be a listing, a set of labels, or both. Sometimes the output is mailed to the Alumni Club.
- **Business Master File Listing.** Sequence: Both donor identification number and alpha on donor name. These two reports are used as reference files.

- **Composite List.** Sequence: Region, chair city then donor name. The output can be produced on hard copy for home office use or on microfiche to be used in the regional offices.

Shown below is an example of the Pledge Reminder form. Additional information is on page 193.



The Campaign for Notr

Public Relations and Development

We thought you would appreciate this reminder of your intent support the University of Notre Dame.

11-01-79	000001-8	5,000 00	500 00	250

Tear off at perforation - keep this half of statement in your own files for federal income tax purposes.

ur continuing interest and your gen-
Notre Dame meet the challenges of
you have mailed your remittance.
Thank you

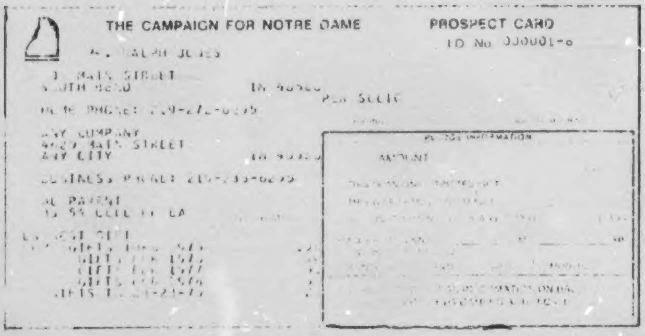
ase provide the correct address

000001-8

46635

tatement with your remittance. Please make ch
otre Dame, Notre Dame, Indiana

Shown below is an example of the Prospect Card. Additional information is on page 194.



THE CAMPAIGN FOR NOTRE DAME

PROSPECT CARD

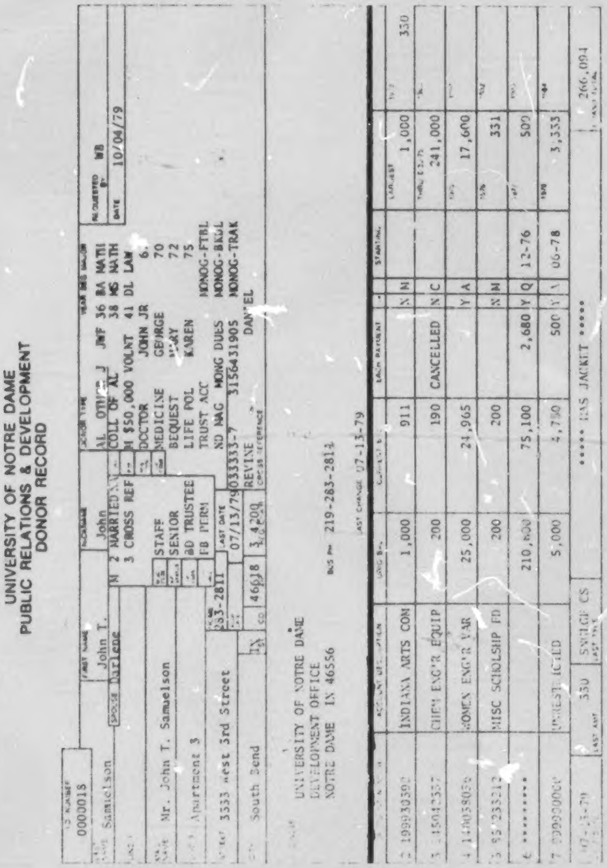
ID No 000001-8

ANY COMPANY

ANY CITY

AMOUNT

Shown below is an example of Donor Record Print. Additional information is on page 190.



UNIVERSITY OF NOTRE DAME
PUBLIC RELATIONS & DEVELOPMENT
DONOR RECORD

ID NUMBER 0000018
Samielson
FIRST NAME John T.
NICKNAME John
SPOUSE Darlene
M 2 MARRIED
3 CROSS REF
Mr. John T. Samuelson
STAFF
SENIOR
BD TRUSTEE
FB PERM
Apartment 3
3333 West 3rd Street
283-2811
LAST DATE 07/13/79
South Bend IN 46618 3 4200

DONOR TYPE		YEAR	DEG	MAJOR
AL OTHER J	JWF	36	BA	MATH
COLL OF AL		38	MS	MATH
M $50,000 VOLNT		41	DL	LAW
DOCTOR	JOHN JR	6.		
MEDICINE	GEORGE	70		
BEQUEST	MARY	72		
LIFE POL	KAREN	75		
TRUST ACC				MONOG-FTBL
ND MAG	MONG DUES			MONOG-BKBL
033333-7	3156431905			MONOG-TRAK
REVINE	DANIEL			

CROSS REFERENCE

REQUESTED BY WB
DATE 10/04/79

UNIVERSITY OF NOTRE DAME
DEVELOPMENT OFFICE
NOTRE DAME IN 46556
BUS PH 219-283-2814

LAST CHANGE 07-13-79

	ACCOUNT DESCRIPTION			EACH PAYMENT			STARTING		
2 199930390	INDIANA ARTS COM	1,000	911		N	M		LARGEST 1,000	330
3 145042337	CHEM ENG'R EQUIP	200	190	CANCELLED	N	C		241,000	
4 140038056	WOMEN ENG'R VAR	25,000	24,965		Y	A		17,600	
5 557233212	MISC SCHOLSHP FD	200	200		N	M		1976 331	
6 *********		210,800	75,100	2,680	Y	Q	12-76	1977 500	
7 999900000	UNRESTRICTED	5,000	4,750	500	Y	A	06-78	1978 3,333	

07-13-79	LAST AMT 330	LAST TYPE SNGLGF CS	***** HAS JACKET *****	266,094

BENEFITS

There are two distinct types of benefits realized from the implementation of the IGS. First, there are the tangible benefits which reflect measurable savings. Among these benefits are:

— There are four fewer clerical personnel.

— Less office space is required because there is no longer a need for centralized file of cards.

— The need for three Addressograph Plate printers and two plate cutting machines has been eliminated. Approximately a quarter million plates were destroyed.

— Today's receipts are deposited today with the carry over practically nil except for year end.

Second, there are those benefits that can not be measured nor can there be a dollar amount attributed to them. In this category are:

— Gifts are acknowledged the day following receipt. This builds goodwill but what is the dollar value?

— Campaign progress reports can be current as of yesterday's transactions. What is the value of timely reports?

— Direct mail solicitation can now be handled on a very personal basis rather than 'dear alumni or friend.' How many more responses will be received from this approach?

— The logistical problems of a large campaign were not made simple with this system, but it did assist in such a way as to make it managable. What was it worth? Pose the question another way. What would the cost have been for a manual system?

— What is it worth to the Alumni Office to be able to create any conceivable report and have that report available the next morning? This is being done!

— Annual reports can be completed the day after a fiscal year is completed. And they are **accurate!** What is that worth?

As can be seen from the above list, each item has value, although we have not attempted to assess a dollar value to them. Notre Dame had very successful capital funds campaigns before the IGS. No attempt has been made to evaluate how much more successful the current campaign was in dollar terms because of the implementation of IGS.

15

Applying Technology to Fund Raising and Alumni Relations

William W. Mercer, Harvard University

Because of the fact that fund raising and alumni relations activities are oriented to organize and motivate a complex and increasingly large constituency of donors and other friends to support advances in a school's mission, technology is a valuable tool. Numbers help to suggest the scale of some of the efforts involved.

- There are about 200,000 living Harvard alumni, organized by the University through 117 active clubs world-wide. Last year the University raised $76 million from private sources. *Harvard Magazine* is mailed to the alumni body on a scheduled basis and mail containing news as well as requests for participation and gifts for University activities continually goes out to alumni and friends.
- Harvard is completing the first year of the Harvard Campaign, a $250 million fund drive to buttress existing programs for undergraduate education within the Faculty of Arts and Sciences. (About $20 million of the overall goal will support a Program in Public Policy, which is based in the John F. Kennedy School of Government).
- About 100 colleges and universities nationally are embarking on drives with goals of $10 million or more. The results of these and similar campaigns should reflect traditional rules of thumb:

- 90% of the donors give 10% of the money received
- 10% of the donors give 90% of the money received
- of these, 1% of the donors give 50% of the money received.

- In fact, the range of gift table for the Harvard Campaign requires that for the Campaign to succeed, 54 donors of at least $1 million (some more) must be found to provide $132 million total. In contrast, there are more than 100,000 campaign prospects.
- Although developed formally as a five-year effort, the Harvard campaign will span well over a decade of the institution's history in terms of planning, implementation, and bookkeeping. The gift receipts functioning as endowment will exist, of course, in perpetuity.

In short, the numbers show, that fund raising and alumni relations is a study in contrasts. The application of technology can not be uniformly effective or appropriate. For instance, the alumni as a whole may receive a copy of *Harvard Magazine* and as a result be more generally informed. And a direct mail appeal may focus on a large constituency. A major donor, however, will respond best in the context of all this information with encouragement from a friend.

This brief outline routine of the activity at one institution suggests that fund raising and alumni relations must be supported by a complex and subtle administrative and social process. Technology is a tool which helps volunteer and staff people put across the right message at the right time. This includes storing records in an easily retrieved fashion over long periods of time, sorting and organizing the records of large numbers of people, and, during fund raising, implementing and tracking the results of direct mail or face-to-face solicitation in difference ways depending on the gift potential of the donor.

A very brief outline of the organization of fund raising at Harvard will be useful background. The University is made up of ten separate faculties and several additional related administrative units. The central organizing principle for the University as a whole is that "every tub rests on its own bottom." The organization, implementation, and funding of educational programs are the responsibility of each dean. As one consequence of this, each faculty has its own fund raising and alumni relations function. Some even have their own computer-based information systems.

The manager of the Development Information System reports to the Director of University Development who in turn reports to the Vice President for Alumni Affairs and Development. As a central University resource, the Vice President's group acts in a coordinating capacity for institutional advancement activities and in direct support of University priorities such as the Harvard campaign.

In brief, the officers which are associated with central University efforts perform the following functions.

I The Development Information System (DIS)

DIS is supported by administrative services in the manager's group, by a records center in Alumni Records, and by a programming and systems group at the Harvard Computing Center. It functions as the central University records and reporting system for alumni records and development and was written by the Harvard Computing Center ten years ago. It is used for recordkeeping for 200,000 living alumni and 100,000 others including parents, widows, friends, corporations, and foundations. The input edit is written in COBOL. The master files are on tapes which are updated and searched with programs which are written in ADPAC. The 300,000 1100 byte records are stored in compressed form in less than one reel of tape on 6400 BPI drives. Access to a 3800 IBM laser printer at the Computing Center, which produces a print line of 150 characters, has been an invaluable enhancement to the ease of use and appearance of copy.

A finder file operates in tandem with the DIS master as an abstract of key data elements used in most retrievals. A preliminary pass of this file permits us to open up and use only that subset of the 300,000 record master file which is pertinent to the retrieval.

Retrievals are combined in groups of 20-25 jobs and run as one batch in the interests of economy. Special retrievals which are complex and/or are one-time events are typically treated on a stand-alone basis. For instance, a recent promotional mailing for *Harvard Magazine* included 18 subsets of significant complexity reflecting the Magazine's growing interest in a more finely-tuned promotional effort.

The master file of DIS data has 225 different data elements including names, two addresses, telephone numbers, schools and degrees, school and volunteer activities for Harvard, prospect ratings, and a variety of background information. The Development Office, Recording Secretary's Office, Alumni Records, and now the Harvard Campaign are the principle conduits through which data changes flow to the system. Data changes for name and address are shared among schools through Alumni Records.

For us, the more traditional uses of the system have included support of a record system of microfiche and paper of the University's alumni, printing, address labels, lists with full background, cards, and special analyses based primarily on row and column matrices. Data design elements that have been particularly useful include six 50 character free-form scratch pad areas which can be used to store messages and comments or which can be redefined by clerical input documents for use as fielded data segments for special applications. In addition, extra one position fields, called attribute codes, are part of each finder file record allowing the quick introduction of new users to the system.

II Alumni Directory

The *Alumni Directory* for Harvard University is published every five years, and for the first time in 1975 and again in 1980, the copy was created by an electronic photo composition process at R.R. Donnelley & Sons, in Chicago, Illinois. They read a pre-formatted tape retrieved from the DIS master file, a process which makes the entire project feasible. The files were used to generate the book's statistic information which includes: counts of alumni by class, school and occupation. A special retrieval tape is used as input to a map drawing program at the Laboratory for Computer Graphics in the Graduate School of Design to produce a three-dimensional map which supplements the statistics. The book numbers some 2000 pages and includes records on 220,000 alumni.

III Class Reports

Every fifth reunion year, each college class publishes a book about its membership. Typically the information is a directory including name, address, occupation, and wife's name. Upon the 25th reunion, a more complete biography for the class is published. Basic copy for the book is derived from the Development Information System and supplemented by updates through questionnaires answered by alumni.

We are exploring a change to the production system to permit installing a word processing system which would help in three ways.

1. Support the questionnaire which precedes publication of the book.
2. Serve as a device in which text could be gathered and edited and then sorted and outputed to a composition service.
3. Assist in producing office correspondence.

IV The Recording Secretary's Office

The Recording Secretary's Office is charged with recording all gifts to the University and creates a master file of gifts tied to the DIS master file through the donor's ID number as a function of gift processing. Reports can be generated from both files in the form of donor listings, mailing labels, and gift matrices, i.e. summaries by department or source.

The most interesting aspect of this application is the use of a Hewlett-Packard mini-computer (the model 3000 Series III) to support the input process and to manage a data base in the Recording Secretary's Office. The configuration includes:

- 768 kilobytes main memory
- 530 megabytes of disk
- 1 tape (1600 BIP)
- 1 600 LPM printer
- 1 30 CPS console
- 32 terminal ports
  - — two dial-up ports
  - — 17 terminals (includes terminals used outside the gift organization)
- languages
- — COBOL
- — Image/Query
- — DEL
- — SPL

The basic gift processing procedure is to enter one transaction per gift in small batches, and once balanced, to up-date the data base and produce daily reports including the following:

1. Acknowledgements
2. Advice notices to pertinent departments.
3. Balance reports to the Treasurer and Financial Office.
4. Weekly output to the financial system.
5. $1000 donor report.

The Recording Secretary's Office and the Development Office use the system for *ad hoc* inquiries into account totals, and donor activity in the current year.

The process is possible because a portion of the data on all 300,000 DIS records is on the Hewlett-Packard for editing and output purposes. We also maintain a file of some 12,000 University Gift Accounts. These and other tables are part of the editing process. The systems are synchronized via up-dates from the DIS weekly maintenance routine.

V The Harvard Campaign

The Harvard Campaign is our major task now and is the context within which to discuss many of the available technological opportunities.

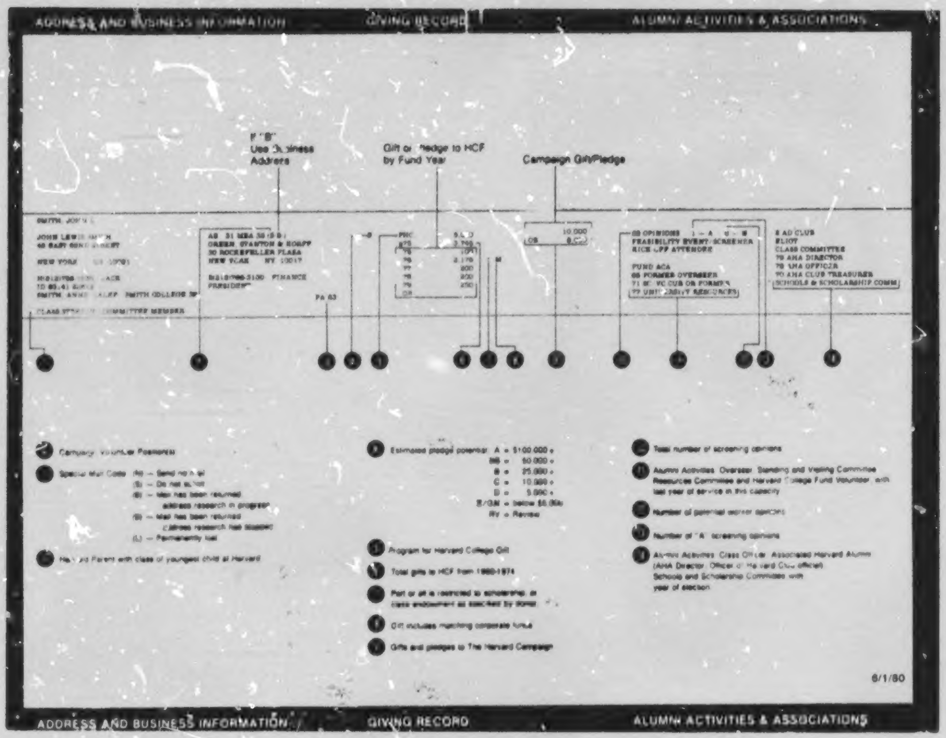
A. **Screening/Rating** — A basic process in fund raising is determining who the best prospects are in order to allocate effectively technological and other resources. This was approached in two ways. First, a computer based algorithm took the opinions of classmates and staff gathered in meetings as well as previous giving records to create a rating which was confirmed or changed by volunteers in a screening process. Secondly, the final opinions on prospects were entered as a rating for campaign purposes. This process was supported by printouts in a variety of sequences and formats. The key intent was simplicity and the clear presentation of a minimal amount of data.

B. **Prospect Reference List** — a "bible" of background information of prospects is printed out every six months on the IBM 3800 printer. The 150 character print line, 11 x 8 paper and the clarity of print are major attractions. (Exhibit 1)

C. **Donor Lists** — A run down of all campaign giving to date is printed four times a year to provide in more detail the status of an individual's giving record to the campaign. We typically include a standard module of background data, the amount of the gift, the date, the type of transaction, its purpose and any background legends (e.g., in whose memory the gift was given).

D. **Acknowledgements/Advices/Statements** — The minicomputer is used to write acknowledgement to donors and to produce daily advice notices in support of a system of volunteer and presidential acknowledgements to donors. Periodi-

Exhibit 1



ADDRESS AND BUSINESS INFORMATION

GIVING RECORD

ALUMNI ACTIVITIES & ASSOCIATIONS

If "B" Use Business Address

Gift or Pledge to HCF by Fund Year

Campaign Gift/Pledge

Campaign Volunteer Positions

Special Mail Code (N) — Send no mail
(S) — Do not solicit
(B) — Mail has been returned
address research in progress
(R) — Mail has been returned
address research has stopped
(L) — Permanently lost

Harvard Parent with class of youngest child at Harvard

Estimated pledge potential: A = $100,000 +
BB = 50,000 +
B = 25,000 +
C = 10,000 +
D = 5,000 +
E/GM = below $5,000
RV = Review

Program for Harvard College Gift

Total gifts to HCF from 1960-1974

Part or all is restricted to scholarship, or class endowment as specified by donor

Gift includes matching corporate funds

Gifts and pledges to The Harvard Campaign

Total number of screening opinions

Alumni Activities: Overseer, Standing and Visiting Committee, Resources Committee and Harvard College Fund Volunteer, with last year of service in this capacity

Number of potential worker opinions

Number of "A" screening opinions

Alumni Activities: Class Officer, Associated Harvard Alumni (AHA Director, Officer of Harvard Club officer) Schools and Scholarship Committee with year of election

6/1/80

ADDRESS AND BUSINESS INFORMATION

GIVING RECORD

ALUMNI ACTIVITIES & ASSOCIATIONS

cally, typically annually, statements will be sent to donors as a function of the reminder process.

E. **Campaign and Class Accounting** — The existence of classes for College alumni represents a strong tradition around which alumni relations and fund raising is built at Harvard. There are a few well understood rules which make the accounting for gifts under the class incentive system different from the Campaign as a whole. Matrices need to be devised and written with this in mind. The rules include:

1) assuring that personal gifts through foundations and other legal instruments including matching gift money appear in the name of the individual for class credit as well as in the record of the legal or originating donor for University records. It must be available to be added to class totals and reconciled to the campaign totals.

2) Full class credit is allowed in the 50th reunion and older classes for deferred gifts, whereas the Campaign total is based on the discounted value as of 1984. Younger classes receive credit for the discounted value only for class and campaign purposes.

3) Income from class endowment gifts receives class but not campaign credit. There is a multiplicative effect of these rules on other data as well which makes the use of computers essential.

F. **Tracking** — We have been able to use the generalized data base package, Image/Query on the Hewlett-Packard 3000, to set up systems for tracking events and important groups of people. This focus on assisting a management process has proven to be a tremendous opportunity for the campaign. While each system shares data definitions for some of the data elements which in turn may be common to the DIS system, DIS and the tracking systems are essentially separate, joined only by a common identification numbering system.

1. **Event Tracking** — As an example, the Boston Kickoff for

the Harvard Campaign involved an invitation list to 2100 people — 1400 people including spouses ended up attending an afternoon and evening event on one of two successive evenings. Each evening, after a group meeting, guests were transported to one of four dining halls for dinner. The tracking system received an initial load from DIS of possible attendees and subsequent maintenance added and subtracted people as necessary. Mailing labels, name tags, attendance records, dining hall assigned, and a variety of tabulation and listings were created, stored and generated with the mini-computer. Up-dated attendance lists were generated continuously until the opening of each event. The overall attendance results are of continuing interest in cultivation activities.

2. **Major Gifts** — A specific tracking system to assist the organization and management of the major gifts prospect pool (prospects rated at $100,000 or more) has also been valuable. Over 35 reports have been developed in the process of providing progress reports by class, area, solicitor, follow-up date, and status, Every week, officers receive a report which, in effect, is a blotter on which all notes and comments are written. This blotter goes through a frequent up-date process, centralized for the purpose of uniformity. Turnaround is virtually instantaneous. Although the pool is small in number (1500 people), the complexities of activities involved in solicitation at this level has made this a valuable aid in the control and management of the organization.

3. **Special Gifts** — There are 15,000 prospects rated between the $5,000 and $100,000 level, and they are organized by class and region for solicitation purposes. A tracking system is being implemented to produce the traditional campaign status reports concerning committee and area progress. Concerns include the number of people assigned, the number of contacts made, gifts received, and assignment completions. Comments and follow-up dates are also of

interest. The campaign period is broken into several 6 month semesters, and the subject of each time frame is solicitation of a major geographic region of the country. Initially, six to ten reports are required on a rapid turnaround basis. In summary, the data elements involved typicaly are not all in the DIS data base, and will not be of continuing interest. Therefore, a "disposable" data base is a surprising and economic opportunity given the availability of Image and Query on our mini-computer.

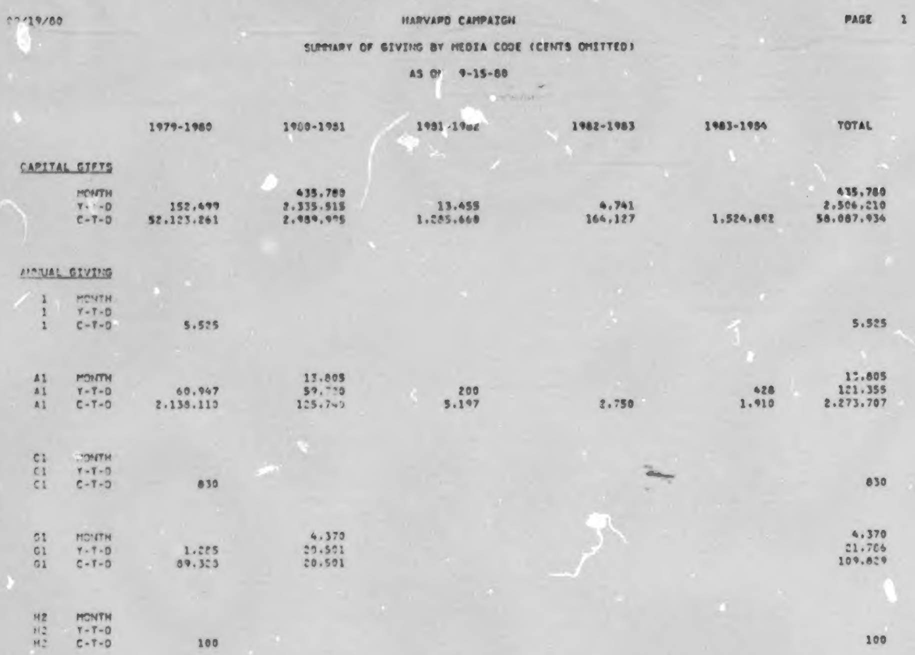
G. **Annual/Capital Giving** — The Harvard Campaign seeks capital and annual gifts throughout the campaign period. The tracking systems are coordinated procedurally to insure that a person is not asked for an annual gift while being solicited for capital giving, or if for specific reasons he should not be solicited during the payout period of the gift. (Exhibit 2)

Having reviewed the need to synthesize data, it should be noted here that we have an established a long standing concern for the privacy of individuals. Giving records and related fundraising information are considered to be private transactions. The preservation of confidentiality is part of the daily routine as all information is shared within the organization as a whole on a limited, "need to know" basis.

H. **Word Processing** — We will be generating the equivalent of auto-typed letters from our files for direct mail appeals in conjunction with telethon prospects rated below $5,000. Because this is viewed as a peak-load requirement, this service will be purchased through outside agencies.

2) We are leasing a one terminal work processing system (which can be expanded to three terminals) for low volume letter generation and text manipulation for the communication's group and for use by staff members for correspondence. This is currently an adjunct to existing magnetic typewriters. At a later time, we will notably decide on larger, more fully articulated word processing system.

Exhibit 2



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09/19/80                                    HARVARD CAMPAIGN                                    PAGE    1

                                 SUMMARY OF GIVING BY MEDIA CODE (CENTS OMITTED)

                                               AS OF  9-15-80


                     1979-1980        1980-1981        1981-1982          1982-1983        1983-1984       TOTAL

CAPITAL GIFTS

          MONTH                         435,780                                                          435,780
          Y-T-D        152,499        2,335,515           13,455              4,741                    2,506,210
          C-T-D     52,123,261        2,989,995        1,285,660            164,127       1,524,892   58,087,934

ANNUAL GIVING

   1      MONTH
   1      Y-T-D
   1      C-T-D          5,525                                                                             5,525


  A1      MONTH                          13,805                                                           13,805
  A1      Y-T-D         60,947           59,780              200                             428         121,355
  A1      C-T-D      2,138,110          125,740            5,197              2,750            1,910       2,273,707


  C1      MONTH
  C1      Y-T-D
  C1      C-T-D            830                                                                               830


  G1      MONTH                           4,370                                                            4,370
  G1      Y-T-D          1,225           20,501                                                           21,726
  G1      C-T-D         89,325           20,501                                                          109,829


  H2      MONTH
  H2      Y-T-D
  H2      C-T-D            100                                                                               100
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VI **Deferred Giving** — The deferred giving staff has achieved significant progress in the use of computers.

1. Analytical programs have been written to calculate charitable reminder factors, and to do cost/benefit figures for life income gifts and charitable lead trusts.
2. In the area of data processing and word processing, the capability has been developed to correspond with life income donors and to respond to standard inquiries in a personalized way.
3. A tracking system has also been developed for prospects and donors, of interest to the deferred giving staff.

The preceding discussion outlines some of the ways technology is being considered and used at Harvard. Techlonogy is a tool primarily used to bring people together. It is worthwhile to note, however, that technology is a function of a management plan. It contributes to the policy development and planning process both by limiting and expanding the overall effort; yet is also subject to it. There is an aspect of people and management in the systems area that bears watching in a major campaign or systems project. The effect of change on people is substantial and their need for reference points and guidance increases in a changing environment.

For example, during the four year period of late 1976 to 1980 a number of personnel changes occurred in the Alumni Affairs and Development Office.

1. The Campaign staff increased by well over 70 people, all of whom needed to be settled in and trained.
2. There have been two Vice-Presidents and three Directors of Development during this period.
3. The lead programmer in the consulting firm who was programming the mini-computer was seriously injured and never returned fully to the project.
4. The senior analyst and chief architect of DIS resigned last year.
5. The original mini-computer acquired for the gift applica-

tion lacked enough capacity and had to be upgraded to the Series III.

6. The Campaign plan changes and evolves over time with an attendant effect on system designs.

In addition, the governance structure of the University tends to encourage a wide participatory approach to solving many problems. It is enough to emphasize that these incidents, and the concerns of anxiety and lack of definition were important management issues. They also reflect the human base for technology in the field of development and alumni relations.

All of the features discussed earlier, suggest in broad measure an integrable series of functions which do not necessarily need to be hosted in one computer system. Clearly, however, given the evolutionary nature of both technology and new ideas, it is most desirable to obtain equipment and software which easily accommodates change and permits a data-processing-like capacity in an office environment. As a result, the identity of data definitions in a variety of processing environments becomes crucial at the office level where it has previously been a concern at an organizational level.

The tracking systems have worked because the fund raising staff has become highly involved. Hopefully, any new systems development which points towards an integrated set of functions will build on the strength of this kind of motivation to the extent that it derives from a creative, hands-on involvement with a system. Because DIS is good sized, it will always need administrative and technical support functions. The basis for further integration would be moving toward the use of electronic storage as a "friendly" way for development officers to store and manipulate data. It is easy to imagine "local" data sets that are part of an informal tracking system of storage and retrieval needs for office and fund raising management. A more formal series of data sets, for instance, gifts and addresses, would be updatable under highly controlled conditions, as part of the continuing University records but also available at a local level for the generation of correspondence, summaries, and donor records.

Given the substantial change which we have seen at Harvard, the tremendously improved cost/benefit ratios for computer hardware and software available in the marketplace, as well as the justified but emerging proliferation of different data bases, it would be advantageous over the long run to look for increased physical and procedural integration of our data resources.

16

Design Considerations of a Campus-Wide Building Control System

Lee A. Hollaar, University of Utah

Introduction

A number of years ago, the Operations and Maintenance Division of the University of Illinois at Urbana-Champaign decided that a centralized control and monitoring system was necessary to manage efficiently the heating, ventilating, and air conditioning (HVAC) systems in the many buildings on campus. At the time, the primary justification for this system was not the conservation of energy, although in later years this would become an important consideration, but the provision for better performance for the eventual users. Problems must be quickly determined and their solutions developed and implemented before they are noticed by the occupants of an area; by the time they notice a problem, call it in, and service personnel arrive, a possible minor problem has become a major difficulty.

It was also felt that with a new system, the mechanical and electrical systems maintenance personnel could be better utilized because skilled staff would be freed from routine inspections of properly functioning equipment. This inspection problem was especially acute for the more than 400 mechanical timeclocks used to cycle the HVAC systems between high and low occupancy (or day and night) modes. With this number of timeclocks, even with a mean time between failures of over a year, on the average one timeclock will fail every day; since there is no means for these failures to be automatically recorded (generally a complaint about the temperature or a fan running continually or not running at all is the first indication of a problem), continual inspection is necessary. In the event of a power failure or change in schedule (school vacation, change of season, etc.) three to four hours of the entire maintenance staff's time is required to reset all 400 timeclocks. It was estimated that, considering only the replacement of the timeclocks and the resulting increase in maintenance personnel efficiency, a campus central management system would pay for itself in about four years. Additional energy savings would further decrease this payout period.

The Phase-I System

Installed in 1977, the first central control system controlled eight buildings located on the south end of campus (near the Physical Plant Service Building, where the main computer was installed). A limited number of digital points were installed in each building, generally consisting of a start/stop control signal for each HVAC system and monitors of successful starting (auxiliary relay contact or sail switch) and the status of the automatical/manual (HOA) switch. The actual HVAC systems have their own control systems, either electrical or pneumatic, which provide for the proper sequencing during startup or shutdown in response to a single control signal. All analog control, such as sequencing based on area temperature, is handled by the HVAC system's internal controls; there are no analog capabilities from the individual buildings.

The only exception to the exclusive use of digital control and sensor points is a Ferranti demand recorder system installed at the University power plant. This demand recorder emits digital pulses at a rate proportional to the total campus electrical demand. It is analog in nature in that its importance is in a value, rather than a simple on or off, but it can easily be interfaced to digital equipment without the converters necessary to connect analog sensors such as thermistors. This input is especially important, since electrical pricing is based on the peak demand from the twelve previous months, encouraging a leveling of demands to reduce changes. (The University currently purchases all its electrical power from the local electrical utility, with the power plant serving as the major entrance to the campus. The power plant is now used for the generation of steam use for heating and air conditioning.)

System Topology

Like many other commercially available systems available at the time, the system installed used a single, centrally located digital computer to selectively monitor and control all the points on the campus. The system behaves as if each point were directly wired to a port on the computer. Of course, it would be prohibitively expensive and dramatically limit future expansion (a goal of Phase-I to have a separate pair of wires connecting control points to ports of the computer. Instead, a point multiplexor was installed in each of the eight buildings. This multiplexor consists of a microprocessor which communicates with the central computer and, based on addresses sent by the central computer, routes information to and from the control points. The microprocessor provided only message routing and was not programmed to provide any control functions of the connected HVAC systems.

The building point multiplexors communicate with the central computer over a polled, multidrop data communications network. Rather than use lines provided by a common carrier, such as the telephone company, or privately owned twisted-pair lines, it was felt that a coaxial cable with separate frequencies assigned for a variety of uses, provided the most flexibility and opportunity for expansion. This decision was enhanced when the campus Computing Services Office decided to utilize a similar cable system to connect its many remote sites; currently the two systems are being integrated to form the backbone of a high-bandwidth campus communications system.

System Problems

During the three years the system has been in operation, a number of problems have occurred which have substantially decreased system utility. In fact, at one point the system became so unreliable that the operational personnel found it more convenient *not* to use the system and they reverted to previous procedures. The system was not achieving the benefits which were expected, and there were serious questions regarding the feasibility of extending it to other campus buildings.

It is now clear that the problems with the system are inherent in the expansion of any central computer control system to handle a large campus rather than a single building and do not stem from a particular incompetence of the equipment supplier. Failure of either the central computer or the communications network render all points inoperative, with no backup facilities available. Unfortunately, due to cable design and installation problems and early temperature control problems with the central computer, this is exactly where the major problems occurred. With a failure of the communications network or the computer, a single thread holding the system together, all control was lost until a repair could be made. This was complicated by the lack of experience of the supplier's technicians and the use of non-standard communication interfaces (such as transmitting 16-bit words rather than standard bytes) which prevented University personnel from using standard troubleshooting procedures.

Although they were marked by the system failures, about half the failures were caused by problems with individual sensors or control points and would probably exist at the same rate in any approach used.

Re-engineering of the cable communications system and improved temperature control at the central system have minimized the global failures to a manageable point, although, since the problem is inherent in the design, it can reoccur at any time.

The Phase-II Approach

Since the benefits of a campus-wide control system remained substantial, it was decided in 1979 to expand the number of buildings controlled from eight to about three dozen. These consisted of most of the major campus buildings, excluding smaller buildings where the benefits would be slight, buildings with unique control problems (such as the Digital Computer Laboratory), and all dormitories (which are operated by a separate maintenance staff).

However, it was also clear that although the central computer could support an expansion of the current system, there would still be single-thread failures which would not affect a greater percentage of the campus. It was also clear that at some point expansion would tax the data handling capacity of the existing cable system, since, although the cable has substantially more capacity, only 9600 baud modems were used. After a number of discussions between the Operations and Maintenance Division and the Computing Services Office, it was decided to use a distributed processing approach, based on the natural hierarchy of central control, buildings, and systems.

Because of the reduced cost of digital computers, it was reasonable to move many of the processing functions from the central computer to the individual building (and eventually to the HVAC systems themselves). Rather than simply a point multiplexor, the building controller now exercises primary control under the direction of the central control computer over its building's systems. Time schedules, policy commands (such as energy reduction requests), and special direct control signals for individual control points are transmitted from the central control computer to the apopropriate building computers. Exceptional status information (such as the failure of a HVAC system to start or stop on schedule) or requested point status is returned to the central computer. This substantially reduces the traffic on the communications network, since only exceptioal point status is normally reported; the central system does not have to sequentially examine each control point to determine if a failure has occurred.

More importantly, if a failure of either the central computer or the communications network occurs, the system can continue to function in a degraded mode. The building control computer continues to operate the HVAC systems according to the last schedule received from the central computer, based on any peculiarities of the building. Although campus-wide demand limiting is not double, reasonable control is being exercised. If it is important to change the last commands or schedule received, maintenance personnel can manually program the building computer using a portable control panel.

The hierarchical approach can be easily extended another level, with the building controller talking to microprocessors associated with individual HVAC or other systems. The same benefits result — the loss of a building controller means only that the individual systems function autonomously according to the last directives from the building controller. Specialized sensors can be connected to the system based on individual system needs. By appropriate message switching commands, the central control computer can access any sensor or control point as if it were directly connected.

The decision was also made to adopt a common protocol for communicating between the central computer and the building computer. All communications are initiated by the central computer, which continually polls the buildings to see if there are any messages. Even if a building does not have anything to communicate, it responds with a NAK (negative acknowledge); the absence of a reponse indicates a possible building computer problem or break in communications, and the polling operation is retired. If a number of buildings simultaneously become unreachable, it is probably due to a failure in the cable data transmission system. A map of the unreachable buildings is used by a special program on the central computer to pinpoint the locations most likely to cause the problem.

Furthermore, all communications is by standard asynchronous techniques (seven bit ASCII characters plus parity, with one stop bit) at 9600 baud. This permits the use of standard data communications test equipment to locate any problems or for periodic quality assurance testing (proof of performance). Test equipment connectors are provided both at the cable attachment point and between the modems and computers so that cables do not have to be disconnected or equipment powered off. This prevents the possibility of resetting the failure and providing normal operation before the cause can be determined.

All communications uses ASCII characters — even numbers are transmitted as a string of ASCII numbers. The first part of any message is the building number, consisting of three digits, with building 000 used to indicate a campus-wide broadcast. Although this adds to the number of bits in each message, it allows better monitoring. As a condition of the contract, the Phase-II supplier is making public the complete protocol used between the central and building computers, so that future expansions to the system will not require identical building equipment or even equipment from the same supplier. Anything which can handle the protocol can be directly attached with minimal changes to the central computer software.

Current Status

The contract for the Phase-II system was signed during the summer of 1980 and work started immediately. Only two levels of the hierarchy are implemented, the central controller and the building controller. All sensors and control points are directly connected to the building controller. Initially only digital points are being implemented, although the supplier must demonstrate analog point capability to allow for future expansion. Wiring of the individual buildings and extension to the cable network have also started, and installation of the first building controllers is anticipated early next year. Initially these will operate independently of any central control to test the building controls and sensors. The cental computer should be installed this summer, and it is hoped that final testing and acceptance will occur in the fall of 1981.

The initial software will provide for directly setting or reading the status of any point in the system and controlling them based on a designated schedule. Deviations from the schedule will be automatically detected and will cause an appropriate alarm. Based on current electrical demand, load shedding and duty cycling will be automatically performed, with the exact actions based on the characteristics of the individual buildings and HVAC systems. Summary information will be saved and periodically printed to determine how the systems are performing. Finally, diagnostic programs will continually monitor the condition of the control system, creating a logfile entry for each problem (either soft or hard) and providing summary information for troubleshooting. Specialized programs can be added to the system when needed to perform new functions or better control a system.

Future Plans

At the present time, another project is proposed to convert some of the electrical or pneumatic control on HVAC systems to microprocessors. These will then be interfaced to the system, adding the third level of the hierarchy. More buildings will also be added to the system, as will additional points, many of them analog. More sophisticated software will provide better monitoring and control, further improving the efficiency of the system.

The University experience has shown that a hierarchically structured campus-wide energy control system, with fixed communications protocols between the levels, not only eliminates most of the difficulties with a centrally controlled, single-thread approach, but also allows for the easy expansion of the system, allowing the selection of the best possible equipment for a particular building. Although there have been some problems, overall the system has been successful and there are high hopes for continued success.

17

The Installation of Central Environment Control (CEC) at Dartmouth College

Rodney A. Morgan, Dartmouth College

A Central Environmental Control system installed at Dartmouth is described in this paper. The term "CEC" or "Central Environmental Control" describes a system which enables a central power plant to program the control of a multitude of energy consuming devices which are located in buildings all over the campus.

Dartmouth's Central Environmental Control serves 42 major academic and administrative buildings on a campus that is approximately a mile and a quarter in diameter. The installation was made in two phases. Fifteen buildings, representing approximately 60% of the energy used on the campus were completed in the first phase, and 27 more, representing about 20% of the energy used on campus, were added two years later during the second phase. Dormitory installations are under consideration for a third phase, but the estimated payback does not appear attractive at this time.

The original cost of Phase I in 1978 was $315,000, of which $100,000 was for Dartmouth College labor employed in the installation. The original proposal called for a payback of three years, but the actual payback, as shown by steam and electrical readings in the buildings served, was 2.1 years. The costs of the installations, including interest, is being amortized over a ten year period. Projected energy savings are carried as cost reductions in the operating budget. These savings are used to pay the amortization costs.

Currently, there are approximately 700 points being monitored or controlled. A control point can be a simple stop-start device, a temperature, humidity, water pressure, or other sensor, or it can be a relay or solenoid tripping any number of sophisticated control devices. All central control equipment is manufactured by Honeywell and marketed as their Delta 1000 system. We are equipped with two, wide-carriage printers, a strip printer in the campus police office, a central console at the power plant (equipped for slide display of specific sensor wiring diagrams) and a cathode ray tube display and console at the buildings and grounds office. The central processing unit at the heating plant consists of a micro-processor with 64K memory capacity. It is specifically programmed for the features required in our specifications.

Following is a description of some of the applications for this equipment:

1. Operating systems are monitored. There are temperature monitors in all buildings served by the CEC and in many specific spaces such as classrooms, galleries, labs, etc. High and low control points are programmed so that temperature variations beyond these limits trigger an alarm in the heating plant. Certain areas such as the galleries, and some auditoriums and laboratories, are monitored for humidity in the same way. Steam pressures are monitored for humidity in the same way. Steam pressures are monitored at the ends of the main lines about a mile from the heating plant, so that better control can be maintained. In all buildings served with pneumatic control systems air pressures are monitored for set conditions and some water pressures are monitored for laboratory buildings.

2. Unit programs are started and stopped as follows: All day startup and night setback times are programmed. A staggered startup schedule is used so that the impact on the central Heating Plant is minimized during the winter months, and buildings are shut down in the afternoon and evening as closely as possible to being vacated. At present, daytime building temperatures are held at 65°F, and nighttime and weekend temperatures are reduced to 50 - 55°F. Many heating, ventilating and air conditioning systems in individual rooms are programmed to different occupancies than the buildings in which they are located. Nearly all major classrooms are programmed according to the Timetable of Class Schedules for regularly scheduled classes and, in addition, for the events scheduled after regular hours by the events office. Since many of the systems serving these areas were designed to operate for the entire class day, many units had to be redesigned to maintain specific temperatures on shorter notice. When programming fails, or when an activity has not been scheduled by the Events Office, then professor and students alike can be quite uncomfortable! Some lighting also is controlled by the computer. Notably, the symbolic library tower flood lights are turned on simultaneously by the computer at their three different locations, and soon the athletic field house main panel will be controlled so that the lights can be turned on only during set times. Finally, all snow melting devices on roofs or in sidewalks are centrally controlled.

3. Ventilation units are cycled at regular intervals producing some of our largest energy savings. Most ventilation and air conditioning equipment is designed for maximum expected occupancy under the worst conditions. With CEC, it is possible to shut off the units during periods where design conditions are not necessary. We have found that many systems can be turned off for up to 40 minutes each hour of operation, while the CEC is watching the temperature and humidity within the space involved to observe a

minimum and maximum of time. In most instances the people who occupy these spaces do not know that the operation of the equipment is intermittent.

4. Complicated programs can be written for optimizing the efficiency of the chillers in the air conditioned spaces. At Dartmouth, office and classroom spaces are not air conditioned, but some auditoriums, galleries, equipment spaces and laboratories are. The CEC turns steam absorption chillers on and off and operates air dampers according to inside and outside temperatures, humidity conditions, etc., making use of cool outside air whenever appropriate. For example, in our performing arts center, a small package chiller serves the gallery areas on days when it is fairly cool. As the day warms up, or when hotter weather arrives in the summertime, the small chiller goes off, and the large chiller comes on to cool all of the center. In this way, precise conditions can be met at the galleries, but the large chiller is activated only when it is badly needed for cooling the bigger auditorium spaces. At Kiewit Computation Center, an extremely complicated program maintains very close temperature and humidity conditions for the computer spaces. Not only is the program designed for best efficiency, but a system of checks and overrides has also been built in, so that if some equipment fails, other equipment can be brought on line to take over.

5. Several burglar alarms around the campus are monitored and on and off signals and alarms are roused to the special CEC printer in the campus police office.

6. There are many logging features to check alarms or to scan limits built into the central CEC controls at the buildings and grounds office, but none are more valuable than the trend log. The computer can scan up to 17 preprogrammed control points at intervals of one minute to 20 minutes, as selected, and print out the value of each point. A 24 hour period can be closely scanned, which is very

helpful in improving programming. It is especially valuable for winning arguments about what happened during the night, after getting complaints. We employed a talented mechanical engineer to monitor and trouble shoot the installation for the first eighteen months, but that is no longer necessary.

Dartmouth currently is not using some of the features of the system. For example:

1. We are not doing "load shedding." Currently there is no need to do this because we cogenerate in our power plant and can adjust our turbine throttles to meet our established peak, exhausting some raw steam in the process. Dartmouth's Power Plant normally produces 17,000 to 40,000 lbs. of steam/hour in the summer and 40,000 to 130,000 lbs. of steam/hour in the winter. Electrical power production varies from 1500 kwh in the summer to 4500 kwh in the winter.
2. We have a separate system for recording fire alarms.
3. A watchmen's tour reporting system feature is not being used.
4. It is possible with the CEC to maintain a card control security system, by adding some equipment in the field, but we have not made use of this feature.

The total BTU's used for steam and electricity in the 1979/80 year cost us $2,300,000. "Cost avoidance" since 1972/73, due to CEC and other efficiency measures, has totalled $3,000,000. With the present predictions that energy costs can only increase, invesments in energy saving measures are probably the best investments we can make.

ACADEMIC

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Document Preparation For Research and Teaching

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In looking at the general field of office automation, one can make several observations. The first is that whatever the term "word processing" once meant, it has been terribly overused and overdefined. Now everyone feels he knows what the term means, yet it means something different to each individual. Word processing also has been subjected to technological overkill. So many neat gadgets abound that it is difficult to determine which are truly useful and which are simply a solution in search of a problem. It is also clear that problems associated with word processing — as is normally the case on a university campus — tend to be humanistic and political, not technical. An examination of the myriads of types of equipment shows that, to a first order, the cost per terminal of a shared-logic system and that of a stand-alone system appears to be the same. Hence cost is not a main issue, and the importance of politics and people is further underscored.

Although we are constantly bombarded with the virtues of "top down" analysis and programming, in the area of document preparation, UC-San Diego started from the bottom up. Instead of trying to arrive at a global definition of "the problem" we began by asking what we might do in this area to maximize the self-interest of the individual faculty member. A university faculty is a unique collection of diverse individuals so it is probable that none of the standard industrial models would be approppariate for showing needs or behavior patterns. A solution that was both productive and promoted the self-interest of the faculty would stand the greatest chance of being successful. Idiosyncracies aside, one of the chief differences between a faculty and the typical office is that a great deal of the textual output from a faculty is creative and effusive. That is, it springs forth naturally from within rather than being stimulated or demanded by external forces or circumstances.

We concluded that we could maximize the self-interest of the faculty member by enabling him to:

a) alter, or perceive that he was altering, campus or departmental priorities in such a way as to improve his overall efficiency or effectiveness,

b) substitute his own time and effort for budget dollars or priority tokens, and

c) minimize the delay time in producing a particular textual product. The delay time for a faculty member starts at the instant he is finished with his creative input, regardless of how long his own efforts may have taken.

One of our historians is an example typical of the faculty. He is in the process of writing a series of books on 14th Century Canon Law. The procedure he had been following is roughly as follows: 1) type a draft chapter at home; 2) after editing the draft, present it to the departmental secretary to type a clean copy; 3) send the clean copy to an editor for notes and comments; 4) give it back to the secretary to type a clean copy, incorporating the changes and corrections; 5) once the editor-author iterations are completed, send the manuscript to a typesetting firm to produce galley proofs. (In this case, since very few linotype operators speak Medieval Latin, the number of corrections was probably greater than normal!)

By the time the chapter had been completed even though no more than 10% of the text had been changed, it had been entered by human keystrokes six or seven times. Over five times the effort of typing the text was redundant.

Using this historian as the nucleus, we added needs of faculty in other fields to generate the total requirements. The requirements for the service were that it should provide:

a) a full range of editing and textual manipulation functions

b) ability to handle mathematical formulae, and to support non-English alphabets (accents, umlauts, tilde, etc.)

c) ability to accommodate multi-author and multi-editor access to a single document

d) ability to perform massive rearrangements of paragraphs and inclusion of previously entered material (boilerplate, stock paragraphs)

Boldface, italics and type size changes were desirable but not absolutely essential. We also preferred general purpose ASCII terminals over special purpose or single purpose terminals.

The results of our selection process lead us to the UNIX system developed by the Bell Laboratories. At that time, UNIX was only available on PDP 11 hardware. To support our faculty we acquired a PDP 11/70 which was installed in the summer of 1979. In addition, two terminals, a Diablo and a CRT, were installed in each academic department. An initial training program was conducted for approximately 120 people, mostly departmental secretaries. Each was given 18 hours of instruction over a period of three weeks. A training manual was developed to serve as a continuing introduction for new users.

The location of the terminals and the style of usage was left as a departmental decision. Some departments, like psychology, were already using UNIX on research computers and were anxious and delighted to do text processing on the central facility. In others, like the physics department, the use was light because the lack of Greek letters on the CRT terminals was considered an impediment. In some departments, several jacks were requested on each line because the terminals are moved from office to office. In other departments, the only user is the departmental secretary; the terminal is locked in her office when she goes home. We provide dial-up lines for those faculty who wish to use the system from home. The system is scheduled to be up 24 hours a day, 7 days a week except for one morning a month for preventive maintenance.

Because of the way computing is handled on the University of California campuses, the document preparation service is self-supporting from recharges to users for the services. The user charges are:

Connect time	$1.00 per hour prime time
	.50 per hour non-prime time (6pm-8am)
Processor	.01 per second
Disk storage	.005/page/month
Typesetter	1.00 per foot

The average total cost to users is about $3.75 per connect hour. The cost of operating the system is approximately $225,000 per year including full amortization of the hardware.

We have come to realize several benefits of using a shared-logic system on a university campus which were not really apparent at the time we made the original decision. Some of the uncertainty was lessened by knowing that acquisition of a PDP 11 was a thoroughly safe decision. That is, if it failed utterly in supporting text editing, it could be immediately used in six or seven laboratories on the campus. The benefits we have found are:

- High quality support for technical notation and foreign accents. Without this capability, the system would be useless to several departments. This area is the bete noire of many otherwise handy and popular systems.
- The blessing of copious storage. The spirit of the user delights in seemingly limitless, low cost mass disk storage.
- Centralized storage makes the development of "electronic mail" trivial. It also, maybe more importantly, allows

centrally located consultants to examine troubled or troubling documents and give aid.

- The language of interaction with the system becomes a widely known dialect. People from all over the campus can discuss techniques and help each other.

One measure of success is the benefit received by the faculty. We have had three books written on the system and innumerable professional papers, journal articles, class notes, bibliographies, research proposals, and just plain letters. Another measure is the amount of usage of the system. Usage is running at capacity during the day and we have just received approval to acquire another machine and replicate the service.

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Document Preparation For Research and Teaching

L.R. Higdon, Virginia Tech Computing Center

BACKGROUND

Virginia Tech (officially, Virginia Polytechnic Institute and State University) has a student population of approximately 20,000 and approximately 7,000 faculty and staff personnel. The Computing Resource Department provides computing services for instruction, research, administration, and extension users. The current computing resource budget is $5.8 million with $1.8 million for salaries. The equipment includes an IBM 3032 Processor Complex with six megs running MVS, JES2, IMS and the student processor (QUICKE). The 3032 drives all peripherals including printers, tapes, plotters, and card readers. There is a 3705 front end processor for the RJE sites. The IBM 370/158 with six megs and the IBM 4341 with four megs runs VM/CMS (time sharing system from IBM). The 158 and 4341 have two Memorex 1380s for asynchronous terminals. Within one of the Memorex boxes are six bysnc lines for remote 3270s. There is also a Honeywell 6880 running Multics for undergraduate instruction.

HOW WORD PROCESSING BEGAN

It used to be that mag card and memory typewriters were the answer to word processing; this has changed. About seven years ago Virginia Tech began using VM/CMS as its time sharing system. Upon the installation of CMS a text formatter called SCRIPT was brought in from the University of Waterloo. The first users were the Computing Center where SCRIPT was used to prepare and publish documentation for users. The output media was a IBM 1403 lineprinter. The next users were a few academics who became interested in how Computer Center documents were being produced and found that SCRIPT could help with reports, proposals, etc.

The users of SCRIPT found that with a time sharing system, multiple authors could work independently entering and changing documents. They could see each other's work and not have to look at a hard copy each time or continually interrupt one another.

But most academics still preferred their mag cards and memory typewriters. Many felt that to do text processing on the main frames was a waste of computer resources; for them secretaries and typewriters were enough.

Still for about four years there was steady growth of SCRIPT users and the Computing Center offered one section per quarter for SCRIPT. The main output media was still the 1403 line printer, but the Computing Center and some of the academic departments purchased daisy wheel type terminals for better quality output. The 1403 was good enough for instructional purposes and the quality of output from daisy wheel terminals was acceptable for nearly all other applications including publications.

Then suddenly, about three years ago, Word Processing and Office Automation became hot buttons. Everyone wanted to get into the game. For many users SCRIPT with the 1403 and the daisy wheel offered acceptable quality; others wanted stand-alone word processing equipment. The first academic departments to order stand-alone word processing systems were the School of Business and Agricultural Economics. Administrative offices received a few stand-alone word processing systems as well.

WHERE WE ARE TODAY

SCRIPT has become the most highly utilized software package on the time sharing system. Currently a little over 50% of our academic departments rely on SCRIPT for research and instructional preparation of material and the Computing Center now offers five to seven sections for SCRIPT per quarter. In the instructional area, SCRIPT is used by faculty to prepare handouts and tests for classes and by students to write papers. The research area is using SCRIPT to write proposals, reports, books, etc. In addition, many secretaries in the academic departments are being trained in the use of SCRIPT. Following are some specific examples of the uses of SCRIPT.

Agricultural Economics, which also has an IBM Office System/6 for word processing, has developed a very nice system on the CMS time sharing system to produce papers, etc. For faculty and students in the department. The secretaries (or anyone else) use CRT terminals to enter the text and use SCRIPT to format it. The line printer is used for rough drafts. Once a document is completed, it is sent to a DIABLO terminal that is on-line at all times (8:00 a.m. to 5:00 p.m.). The software driving the DIABLO queues the documents, prints them in priority order, with the forms requested by the user, and charges the users account.

The Architecture and Urban Studies School has been using SCRIPT to do word processing for years. Among the first to train departmental secretaries, it has set up special software so that the system is easier for them to use. In addition, because the school uses the time sharing system for document preparation, they have not had to add additional secretaries.

The English department has made use of SCRIPT for the preparation of books. The author inputs the text, formats it, and makes changes until it is complete. A tape is then created from the raw text and sent to the printers.

The Graduate School has just implemented a policy that provides a graduate student with $100 to write his/her thesis or disseration using the time sharing services. Special SCRIPT macros that define the layout needed for theses or dissertations are available for these students.

ECONOMICS OF USING TIME SHARING SYSTEMS

Academic departments have chosen a time sharing system over stand-alone word processing equipment in part because operational budgets are very limited. The pure economics of the choice is interesting. For the price of a stand-alone word processing system, one can buy a daisy wheel terminal and four to six other terminals (CRTs). For the cost of an additional work station, one can buy three or four terminals. Clearly a time sharing system is considerably cheaper. In addition, the computer credits allocated to an academic department is separate from its operational budget and is like "funny money". Many of the departments are using these credits to do text processing as well as the traditional types of computing.

WHAT WE ARE PLANNING

Even though there is heavy usage of SCRIPT and several stand-alone word processors, there are still missing links to provide the services the users need. The daisy wheel terminals do provide a quality that can be used for many documents, but it is not good enough for others. Also, switching print wheels to get mathematical or Greek symbols is difficult and cumbersome. In response to this, the Computing Center is testing and planning for different output media.

Currently a SHAFTSTALL unit has been installed as a RJE device to route SCRIPT files to a floppy disk. They can then be processed by the photocomposition unit. In the past, the user would use SCRIPT to develop the document and then would have to take a hard copy to the print shop where they would reenter into the photocomposition unit. We are also routing files from Office System/6 to the photocomposition device in the print shop. Although the software is not totally finished, it already offers greater flexibility to users.

To provide better quality printing in the Computing Center, an IBM 6670 printer will be installed. This printer will provide six different fonts and a copy function as well as high quality printing. Access to the 6670 will be from the time sharing system and word processing systems that have an RJE link to the Computing Center. The first 6670 is a prototype; we foresee groups on campus eventually buying their own.

DEVELOPING STRATEGY

Often a university is faced with reacting to situations rather than being able to plan and develop strategy. To help control this for word processing and office automation, Virginia Tech created the position of word processing coordinator, which is part of the development group. The coordinator provides users with suggestions on how to do things and tries to lead the users to continuity in the way the University addresses and handles word processing. This person also sets up policies and procedures, and chairs the University Word Processing Committee, a function just now getting started.

Reacting to and anticipating user needs for word processing is a challenge for Virginia Tech. As technology improves we must be in a position to provide a better and more complete service.

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Changes in Latitudes, Changes in Attitudes

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I. INTRODUCTION

"Changes in Latitudes, Changes in Attitudes" quite accurately describes what the North Carolina Educational Computing Service (NCECS) has been about in the past three years. This paper illustrates how this theme pervades NCECS' approach to promoting computer literacy among network faculty through their use of mainframes, minicomputers and microcomputers.

From its founding, NCECS has been committed to promoting and enchancing the level of computer literacy among faculty members throughout the State of North Carolina. Until three years ago, the primary model for accomplishing this goal was through an interrelated program of faculty training workshops and development of a curriculum support library. Over time this program was expanded and altered.

The model for delivering computer-based curriculum materials (CBCM) for research and instruction, which will be discussed briefly later in this paper, depended heavily on reviews of these materials by North Carolina faculty and commensurate development of the materials by NCECS staff so as to make them suitable for use in a network environment. In the past three years NCECS' attitudes about this model have changed significantly. While this model served the network well for many years, the increased availability of high quality CBCM, coupled with the establishment and the maturation of organizations concerned with the screening, review, and testing of CBCM, has lead us to adopt a new strategy for procurement of materials for the NCECS curriculum support library. Most of the new materials in the NCECS library are imported (as they have been in the past), but now prior to being imported, they are subject to external peer and technical review. This notion, will be expanded upon, with examples, throughout this paper.

Our latitudes have changed a great deal, figuratively as well as geographically. NCECS has traditionally provided services on, and support of mainframe computers. However the advent of microcomputers, and the increasing availability of high quality CBCM for these devices, has resulted in the development of a plan to support stand-alone microcomputers for instruction and research applications on a statewide level.

To be geographically correct, NCECS' longitudes have changed as well. We are committed to involving as many faculty in the use of CBCM as posssible. To accomplish this goal requires that we have a practically inexhaustible supply of materials available in a variety of disciplines. Of course no one has such a richly endowed library, so the only way to reasonably meet this goal is to look to other supplers for materials which are too expensive, difficult, or esoteric to import. Thus we now distribute services from at least eight different resource sharing organizations located throughout the United States. These services are discussed in the paper by Louis T. Parker, Jr. (1).

This paper will demonstrate how our changes in attitudes — moving from a coordinating development and review based organization to a clearinghouse based organization and changes in latitudes — looking to other hosts for services and supporting microcomputers have substantially enhanced our ability to promote computer literacy among network faculty.

II. NETWORK DESCRIPTION

NCECS is one of the oldest regional computing networks in the country. Founded in 1966 on the assumption that colleges without computer access would subsequently offer a qualitatively different and inferior education, NCECS is today a division of the University of North Carolina General Administration and is the central organization for a network of 58 institutions most of which are in the higher education sector. NCECS purchases machine time from the Triangle Universities Computation Center (TUCC) and other suppliers and distributes that machine time, together with a variety of staff support services, to colleges and universities throughout North Carolina. Many of the curriculum support services designed to promote computer literacy are available to non-network schools as well. Two previously published papers cover the history and development of NCECS and corresponding curriculum development activities (2,3).

III. PALS MODEL

In 1969 NCECS received a National Science Foundation (NSF) grant which enabled the organization to implement many curriculum development activities. The "PALS" (Program and Literature Service) model was developed under this grant to deliver CBCM. The model was characterized by statewide faculty review of CBCM as well as training of, and communication between, interested faculty. The PALS model, illustrated in Figure 1, is described extensively in another paper (2). Only its salient features are outlined here.

An NCECS manager of curriculum materials, with a funded programming staff and sponsored faculty, researched the availability of CBCM. Materials not yet brought "on board," but known to NCECS, were placed in category IC. When materials reached NCECS, and were judged potentially supportable, they were placed in category IB. Workshops, supported projects, and other "push" mechanisms were used to bring the materials to the faculty for review. A favorable faculty review resulted in

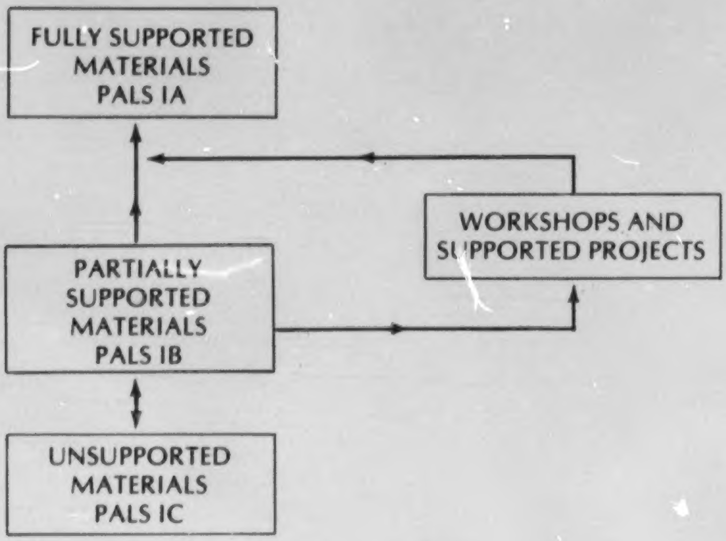
FULLY SUPPORTED MATERIALS PALS IA
WORKSHOPS AND SUPPORTED PROJECTS
PARTIALLY SUPPORTED MATERIALS PALS IB
UNSUPPORTED MATERIALS PALS IC

Figure 1

materials moving to IA status. Some immediately compelling materials were moved to category IA without faculty review.

This model to deliver CBCM was aided immeasurably in 1972-73 by the NSF funded CONDUIT experiment to transport materials between five funded regional networks and the NCECS-sponsored 1973 Institute of Undergraduate Curricular Reform (IUCR). The IUCR was charactgerized by extensive faculty workshops which included significant training in quantitative methods. The more intensive IUCR workshops effected a high level of adoption of CBCM by faculty participants.

The PALS model, and the funded projects (CONDUIT and IUCR), produced a strong central library of materials which is essential to the growth of instructional use of the computer. The library allowed faculty with no prior knowledge of, or experience with computers, to use the well-documented "canned" curriculum support materials effectively in the classroom. Under the PALS model, NCECS did a significant amount of development work to bring materials to IA status. The extensive participation in the review, transportation, documentation, and teaching of these materials by selected faculty was made possible through NSF grant support of these activities. Although these projects enhanced the level of computer literacy among the many faculty who participated, long term grant support of these activities was not a realistic option.

IV. NEW STRATEGIES FOR DEVELOPING A COMPUTER LITERATE FACULTY

Faculty are more likely to become computer literate if a broad base of CBCM are readily available, are well-documented, have undergone peer review and in-class testing, and are easily accessed. There should also be a strong central "people" support organization to back the materials and provide training in their use. Given these criteria, NCECS began three years ago to look to other sources of CBCM. Two major sources were tapped: vendors of reviewed and tested materials, and external hosts.

1) Providers of transportable, well-documented, peer reviewed, screened, and tested materials

One such provider, CONDUIT, has become a primary, but not exclusive, source. A CONDUIT product typically consists of a complete package which includes student and instructor manuals as well as transportable software. CONDUIT has engaged in research on ways to make instructional computing more effective. This research impacts their products and improves their quality. Since NCECS' computer literacy efforts depend heavily on marketing, the high quality of materials available from CONDUIT improve our chances for promoting computer literacy. Our fundamental role relative to CONDUIT and other similar sources then becomes that of a clearinghouse for procurement of, information about, and substantive training on the use of these quality materials. This is quite different from the development role described in the PALS model.

2) External hosts

NCECS currently acts as a local distributor for the services of the following external hosts or resource sharing organizations (RSOS): EDUNET, Dartmouth College, HEN (Health Education Network), MSTL (Medical Sciences Teaching Laboratory of the University of North Carolina at Chapel Hill), and RLIN (Research Libraries Information Network). The distribution functions include locating and marketing resources, user services, and account initiation and billing. We believe and have demonstrated that providing these functions substantially enhances our ability to promote computer literacy. Because we can provide access to a vastly increased number of resources for our network faculty, we can market to a broader spectrum of faculty.

Our experience in EDUNET bears this argument out. During the prototype stage of EDUNET, we opened more EDUNET accounts for North Carolina faculty than any other participating institution (and today we reamin among the leaders in accounts opened). We have been able to identify the following reasons for this success:

1. A number of novice users opened accounts to use unique or specialized resources which were not available on the TUCC machines.

2. Some users opened accounts to test resources before considering local implementation.

3. Some experienced users opened accounts to use sophisticated, complex, or esoteric resources which were not available locally and which were used in sufficiently small volume to obviate against importation.

4. One user opened an account to use materials on an external host computer because he could consult with the materials' author, a faculty member at that host institution, on how to use the resources most effectively.

5. Some users opened accounts to explore large, instructional libraries at other hosts.

6. Some users opened accounts to use teleconferencing or electronic mail systems to facilitate communication between researchers who were geographically separated.

A common theme pervades all of these reasons. Compelling products, heretofore unavailable locally, but available through an external host computer or resource sharing organization, caused increased use of computer by faculty, and consequently raised their level of computer literacy. Marketing of these resources was and still is an important factor in promoting their use, and marketing techniques will be discussed in the section of this paper dealing with workshops. A more complete description of the NCECS EDUNET experience can be found in the article by B.L. Berman (4).

V. CURRICULAR SUPPORT FUNCTIONS

The previous section explained how NCECS has sought to enhance computer literacy by increasing the quality and quantity of options available to network constituents. This section illustrates how organizational structure and on going training activities are designed to enhance computer literacy as well.

The problem of developing a computer literate faculty is compounded in a network environment. NCECS serves 58 institutions, each with its own mission, special problems, and individual character. If one looks at these institutions, one finds heterogeneities in type (public, private, four-year, two-year, traditionally black, etc.); in size; and in the resources each can allocate to computing. The problem is further exacerbated by the geographic dispersion of these institutions. North Carolina is a fairly sizeable state, and some of our network member institutions are located as far as 300 miles from our headquarters in Research Triangle Park. It should be noted that most of the institutions in the NCECS network are instruction intensive rather than research intensive.

In order to deal with the special problems of developing a computer literate faculty imposed by the regional network environment, we have developed and constantly improved a program of curriculum support functions integral to the state-funded services of NCECS, and designed to meet the needs of our heterogenous constituency. These functions include a regular schedule of discipline-oriented workshops, training workshops, and special interest group meetings. Many of these workshops and meetings are open to faculty from non-network as well as network institutions in North Carolina. We also offer on-campus workshops specifically tailored to the needs of the sponsoring institution, special topic workshops, and "live" demonstrations for faculty who request them. Finally, we offer a broad range of other computer literacy-enchancing services, each of which will be described in this section.

Many of our curriculum support functions are performed by our Academic Services staff, a specific group whose primary responsibility is to deliver academic services. In order to train faculty in the use of CBCM, our Academic Services staff is required to be familiar with computer-based curriculum applications and with techniqes for use of CBCM in the classroom. In addition they are expected to keep current on the state-of-the-art in CBCM. The Academic Services staff is currently composed of a person with seven years of full time college teaching experience, a person who has co-authorized a CONDUIT package, a microcomputer specialist, and a computer-based curriculum specialist. We feel it is essential to have staff with these competencies and experience if we are to provide effective training in the use of CBCM in order to advance the state of computer literacy. An earlier paper refers to the "bridging role" served by these staff members (2).

Specific descriptions of our program of curriculum support functions follow.

1. Training Workshops — NCECS offers training workshops in the use of particular packages, e.g., SAS and SPSS; or particular systems, e.g., TSO. These workshops are, with some exceptions, offered by our User Services staff as opposed to the Academic Services staff.

2. Special Interest Group Meetings — NCECS sponsors these meetings in order to assemble a group with common interests, foster communication between members of the group, and more effectively assess the requirements of members of the group. If we can learn the requirements of the group, we can enhance computer literacy by responding to needs. Examples of themes covered at Special Interest Group Meetings include microcomputers and administrative data processing.

3. Discipline Workshops — NCECS sponsor approximately three to four discipline-based (e.g. physics, sociology, history) workshop per academic year. Workshop invitations are sent to every faculty member in the state in the related discipline irrespective of their institution's network affiliation. Each workshop participant receives an extensive packet of resource information which speaks to the availability of CBCM in the discipline (be they available locally, through RSOs, or through other sources).

The workshops are designed to meet the needs of both novices and experienced users. The discipline workshop model has evolved over time, and should continue to change. Typically, the current discipline workshop agenda has the following components.

a) **Presentations by Users of Discipline-related Materials** — We call on the North Carolina faculty who are using CBCM and other discipline-related materials in their courses to make informal fifteen minute presentations on what they are doing. This component is an example of using our faculty as resource people to serve as role models for attendees, particularly novice users. This component also allows all workshop participants to gain a sense of "who is doing what" with computers in North Carolina.

b) **Demonstrations** — We demonstrate pertinent materials which reside on the TUCC system and on EDUNET or other RSO host systems. In addition we also demonstrate microcomputer materials. CONDUIT, for example, is currently distributing an ever-increasing number of instructional materials for microcomputers. These demonstrations are performed by faculty, who often relate the material to their own earlier presentations, and by NCECS staff, who also discuss the use of the materials in an instructional setting.

c) **Hands-on Experience** — We firmly believe that faculty will be inspired, and hence more likely to use materials, if they feel they have had some hands-on experience. Every discipline workshop has a hands-on component which allows faculty to access resources which have either been demonstrated in an earlier session or described in the resource packets. Enough computer terminals are provided to afford every participant the opportunity to gain this experience.

d) **Evaluation** — This component allows us to evaluate the effectiveness of the workshop, assess demands for new products and services, and solicit reviews of materials which were demonstrated or used in the hands-on session.

4. On-Campus Workshops — We hold these workshops in response to requests from network (or potential network) institutions. By tailoring these workshops, we can respond to specific institutional needs and consequently promote computer literacy explicitly.

5. Demonstrations — When requested, and when staff time allows for them, we perform demonstrations of TUCC, EDUNET, CONDUIT and other RSO packages, microcomputer software, and other resources. Working one-on-one with faculty is a very productive technique for stimulating faculty interest in computer-based resources.

6. Special Topics Workshops — On special occasions we offer, upon request, special topics workshops. For example, we have offered a number of workshops and training sessions devoted specifically to the availability and use of EDUNET resources (5).

7. Library of Curriculum Support Packages and Corresponding Documentation — The NCECS curriculum support library has been described earlier in this paper. The library resides at TUCC and includes materials from twelve academic disciplines. These materials are very well documented, a feature we feel is essential if they are to be used effectively and without problems. We also maintain a library of resource materials within our offices. Faculty are welcome to visit (and many do) to browse in this library, to use resource materials for self-training, and to consult with staff. The resource materials include complete resource packets on every program in our curriculum support library, EDUNET documentation, discipline-based state-of-the-art files, and microcomputer resource files.

8. Telephone Consultation — NCECS maintains two toll-free telephone numbers which allow faculty throughtout the state to call for individual consultation. Because of the geographic dispersion of our faculty, telephone consultation is a heavily utilized and effective literacy enhancing service. Telephone consultation is also an effective means for the NCECS staff to do ad hoc user needs assessment which allows us to be more responsive to the needs of network constituents.

9. Colleague Referral — One of the philosophical underpinnings of NCECS is the notion that we are a "people network" as well as a supplier of computing time and academic services. As such, our staff keeps informed about the activities of network members and can thus provide users with colleague referral information.

10. Participation in and Sponsorship of Professional Conferences — NCECS participates in professional conferences in order to promote computer literacy and market products and services. For example, we are a sponsor of the 1980 North American Simulation and Gaming Association (NASAGA) Annual Conference being held at the University of North Carolina at Asheville.

11. Newsletters — NCECS, like most suppliers of computing services, publishes Newsletters and Newsbriefs to keep users abreast of new products, services, etc.

VI. MICROCOMPUTER SUPPORT

NCECS, through special interest group meetings and communication with national experts in the field, has been assessing the effect of personal computers on faculty attitudes toward, and the use of, these types of computers for teaching and research. Their low cost, relative ease of use, reliability, special features such as graphics and color, excellent response time, friendliness, and multifunction capabilities make them computer literacy amplifiers. The multifunction capabilities of particular interest to us include microcomputer use in stand-alone applications, as terminals to mainframe computers for file transfer and in interactive computing applications, and in word processing applications. Because they are less intimidating than their mainframe counterparts, we see microcomputers as a vehicle to promote computer literacy among a wide audience of novice users as well as experienced users.

During 1980, NCECS has introduced microcomputer support services. We see these services as integral to the organizational philosophy of promoting computer literacy. Brief descriptions of the services offered or those planned follow.

1. **Intelligent Terminal Software** — We feel microcomputer users will eventually exhaust the stand-alone capabilities of their machines. It is also likely they will wish to continue to access instructional libraries on mainframe computers. Finally it is likely that users will demand services which allow microcomputers to prepare jobs offline for the mainframe computer and then upload these jobs to and download output from the mainframe. In response to these likelihoods, we have developed terminal software which allows an Apple II to serve as an intelligent terminal to TUCC system plus certain EDUNET suppliers. Intelligent terminal software provides the convenient, friendly user interface so necessary to overcome the barriers to mainframe use. Also, by preparing jobs offline, the user need only learn a single, full screen microcomputer editor such as that provided with the UCSD Pascal Operating System.

2. Hardware and Software — A director of a national ROS recently likened the purchase of microcomputers to that of Barbie dolls by observing that while the basic doll is relatively inexpensive, the price of the clothes quickly becomes prohibitive. By providing a "consumer report" consulting service on microcomputer hardware and software, we hope to stimulate computer use by additional faculty in the selection of microcomputer systems which are most commensurate with their needs.

3. Bulletin Board Systems — Computer literacy can be enhanced by facilitating the direct sharing of information between users. We are currently investigating microcomputer-based bulletin board systems to automate the microcomputer information exchange process. Our small staff cannot realistically keep current on all aspects of the fast-evolving microcomputer field. A bulletin board system would enable us to use faculty more efficiently as resource people.

4. Information Clearinghouse — We will serve as a clearinghouse for general information on the availability of microcomputer discount plans, hardware, software, etc.

5. Training Workshops — We will offer training workshops on the use of terminal software, the UCSD Pascal Operating System, the availability of "canned" CBCM for microcomputers, and relative comparisons between different microcomputers. These workshops are designed to meet the needs of the novice as well as the experienced user, and consequently should reach a wider audience of potential users. Two such workshops are planned for the academic year 1980-81.

6. Transportability Standards — If CBCM can be written using a transportable language, more people are likely to use them (given the increasing numbers of different microcomputers available). We are currently supporting UCSD Pascal as a transportable language standard.

7. Microcomputer Technical Notes and Documentation Series — We have developed a microcomputer documentation series which thus far deals with system discounts and terminal software. We have also begun a technical notes series, entitled MicroBits, which contains answers to questions most frequently asked of us (or questions we feel people should be asking) about microcomputers.

VII. CONCLUSIONS

The substantive program of curricular support functions, the strategies for increasing the quality and quantity of resource options available to network faculty, and the network support of microcomputers have greatly enhanced our abilities to stimulate computer literacy in the network. As proof, demand for and interest in NCECS services has increased; telephone consultation has increased; workshop attendance has increased (at a time when state restrictions on travel would ordinarily reduce attendance); demand for EDUNET and other RSO services has increased; demand for microcomputer services of every kind has increased; demand for CONDUIT resources has increased; and use of the TUCC mainframe computers has increased. There is also evidence that as a direct result of our workshops and other curriculum support functions, computer activity has increased at non-member institutions as well. The NCECS "Changes in Latitudes, Changes in Attitudes" posture has resulted in the network being more responsive to the needs of faculty, and consequently to produce, both explicitly and implicitly, a greater state of computer literacy among network faculty.

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Developing a Computer Literate Faculty At College of DuPage

Bart Carlson, College of DuPage

INTRODUCTION

College of DuPage is a comprehensive community college established in 1966 in ten high school districts of Chicago, Illinois. Since 1967, student enrollment has grown from fewer than 3,000 students to more than 26,000 students. The College offers a variety of programs that include the first two years of baccalaureate education, career education, general studies, community education, and public service activities.

The main campus is located in Glen Ellyn, Illinois; but classes are also held in over 50 locations throughout the county to provide greater accessibility to the College by district residents.

Computer Services

Computing at College of DuPage began with an IBM 360/30 maxi-computer in a trailer in 1967 and progressed to a position of leadership in higher education terminal based administrative systems in the 70's. Much of the development of on-line systems was sparked by a grant to develop an interactive terminal based counseling program (CVIS — Counseling and Vocational Information System). This terminal communication system was the base from which the registration, financial accounting, library, and other administrative systems were developed. Computer Services is managed by the Computer Services Management Committee (CSMC). Membership on the CSMC consists of the president, the two provosts and the three vice presidents. The CSMC, which has direct line responsibility for Computer Services (as well as for all other functions in the institution simply because of their collective individual positions within the institution), meets once a month.

Two other advisory committees are also included in this management model. The Academic Computing Users Advisory Committee, which also meets monthly, consists of a mixture of academic faculty and academic administration. As its name implies it focuses on the computing resources which primarily support faculty and students. A third committee focuses primarily on administrative users of computing and is called the Administrative Systems Users Advisory Committee.

During the 70's the institution continued to expand, as did demands on the CVIS system. Academic uses of computers however, was limited primarily to supporting the data processing curriculum (and computer science). This to the proverbial "chicken and egg" syndrome. Whatever the cause/effect, it was important, however, that academic use be planned for in the future. In 1978, the administration recognized the need for an overall master plan for long-range computer services.

Memorandum of Opinion

Up until the fall of 1978, academic and administrative departments were buying computer related equipment and software items without any overall plan or coordination. This practice was prolific because the technological advances being made in the industry pushed prices to new all-time low levels. A department could acquire a terminal, microcomputer, or minicomputer for only a few hundred to a few thousand dollars.

As the college began to develop an overall plan, it became clear that an eight-year plan could not be developed which would encompass every possible future use of micro- and mini-processor technology. This included security systems, typesetting machines, voice telephones systems, microcomputers, minicomputers, and text or word processing systems among many others. Since individual departments were continuing to acquire computer related equipment and software as the development of the long-range plan progressed, Computer Services became increasingly concerned that items being acquired now may not be compatible with the overall direction the institution would be choosing for the next decade. Immediately a search began for an internal mechanism or procedure which would solve both problems, i.e., individual departments buying computer related items without overall coordination and the inability to spell out every item which computer technology might penetrate in the next eight years.

After considering a number of alternatives, a decision was made to submit a formal recommendation to the Computer Service Management Committee for their review, consideration, and approval. The recommendation, entitled "Coordination of Instructional and Administrative Computer Related Equipment and Software Acquisitions," is listed below in its entirety.

Recommendations:

> CSMC hereby creates the administrative policy requiring that all computer related equipment and software acquisitions be formally reviewed in writing via a "memorandum of opinion" by Computer Serices prior to acquisition and that said policy be monitored and enforced by the C/D Purchasing Department, Final approval of said acquisitions will rest with the CSMC.

This policy recommendation was approved in December 1978, and the College of DuPage has continued to operate under its guidance and direction since that time.

Another issue of importance which was discussed was whether or not an item price level should be included or excluded from the policy. It was decided that the policy should be all encompassing, and that if experience demonstrated that it needed to be refined, it could be modified at a later date.

The recommendation was fairly well received and had some interesting results. However, as is often the case with any change of this magnitude, some "period of adjustment" and "tuning" in the process was necessary. Since the policy was implemented in mid-year, literally months after the individual departments had budgets "approved" at the highest level, it was a shock for some of them to find out they needed to go through a new level of review, justification, and approval. This, however, was only a start-up problem during the first year. For the second year, this review was tied in prior to budget "approval" at the highest level, and therefore the "memorandum of opinion" process was in the budget preparation cycle where it belongs.

Long-Range Computer Services Master Plan

In the spring of 1979, Computer Services staff developed a formal long-range plan for review by the Computer Services Management Committee. This plan described the mission, philosophy, goals and history of both College of DuPage and Computer Services, and discussed computing industry trends. The plan included detailed sections on functional requirements for both academic computing and administrative systems, a technical plan for computing hardware and software (showing several alternatives), and a financial plan.

The long-range plan was approved in June 1979 by the Computer Services Management Committee and the Board of Trustees. Implementation of the plan began almost immediately.

Of particular interest was the section on industry trends relating to hardware, software, and staffing. These sections concluded that, for College of DuPage, the best course of action was to invest in commercially developed and maintained software rather than in a larger staff. As a result of this conclusion, the Computer Services Department has a very competent but small staff of 17 people.

Computer Hardware and Software

The current hardware at College of DuPage includes an IBM 370/138 maxi-computer for administrative systems and some academic computing (an IBM 4341 is on order for December 1980), a Hewlett-Packard 3000 minicomputer for academic computing, and a DEC 11/34 minicomputer for the CLSI system for the Library Computer Services also operates an NCS-7008 minicomputer based optical mark reader.

In addition to local hardware, College of DuPage also uses the PLATO System at the University of Illinois, the EDUNET Network, the OCLC Library Network, and MDSI in Ann Arbor, Michigan.

Recognizing the increased role of microcomputers in education, Computer Services has recently acquired over fifty Radio Shack TRS-80's, Apple II's, Commodore Pets, and a Texas Instrument 99/4 among others. Many of these fifty plus microcomputers and over one hundred terminals are connected to the minicomputers and maxicomputer described above. Many are hard wired but some have dial-up capabilities.

Of particular interest is the use of numerous Lear-Sieglar ADM 3A CRT terminals which can dial-up all of the systems described above. In addition to being just an asynchronous terminal, they can access the IBM 370 maxi-computer in an "IBM 3270 mode" via a protocol converter box located at the central computer site. It allows use of all the hundreds of programs which were written to support the IBM 3270 terminals only.

Computer Awareness Training for Staff (CATS)

As implementation of the plan began, it became readily apparent that a series of short courses for faculty, administration, and staff were needed. The objectives of three courses would be to increase general awareness of computers and their capabilities and to broaden the skills of current and potential users. The teaching techniques would include lectures, "hands-on" experience, and self study methods.

The responsibility for developing a training program was assigned to the Academic Computing Department in Computer Services. Since it appeared that this area could better tune in on the needs of faculty as well as other college staff.

The CATS program has a course catalog indicating course names, course numbers, course descriptions, course objectives, course syllabus, and course pre-requisites. Several alternate paths of instruction can be selected depending on the unique needs and interests of the user. However, all users are required to start with the Introduction to Computer Services Facilities and Resources, a six contract hour course offered on two separate days which like all of CATS courses, can be taken by faculty for credit on the salary schedule. Whether a course is taken for credit or not, each completer receives a certificate of completion signed by the instructor and the Director of Computer Services.

A schedule of courses to be developed should keep interested persons involved. Two new courses being implemented during fall term 1980 are Introduction to the PANVALET Editor and Basic programming.

Monthly Newsletter

The task of keeping a large, diverse, and unique user community informed on a timely basis has historically been a challenge for many colleges the size of C/D or larger. C/D, with its adoption and subsequent implementation of the Long-Range Computer Services Master Plan, found itself in a very similar position primarily because of two factors:

1. The long-range plan in its comprehensive approach dealt with, for the first time at C/D, academic computing

needs beyond the traditional data processing courses. In addition, the long-range plan expanded the administrative uses of computing resources into new and smaller areas of the college, areas which, for the most part, had not previously seen much usage. Unfortunately, the old approach of walking down the hall and telling a handful of people or sending out a memo to a few more with the news of a new procedure or change was no longer a viable method for keeping users informed. This expansion to a new community of inexperienced users required a whole new approach.

2. The long-range plan also broadened the types of computing resources available to the user community at C/D. For the first time the user could select the computing resource appropriate for the task at hand, whether it be one of serveral kinds of microcomputers, or minicomputers, a maxicomputer, or another computer at a distant college. Each of these systems has different and constantly changing systems, compilers, utilities, data bases, operating procedures and sign-on procedures.

In January, 1980, Computer Services began publishing a monthly newsletter to keep its academic and administrative user communities informed on the equipment, software, personnel, operational, procedural, technical, and developmental changes occurring at College of DuPage. Eight months later Computer Services conducted a survey of all newsletter subscribers to determine if the initial objectives were being met. The preliminary results indicate a very positive result. In addition to these results another indicator may be the overwhelming number of requests which have been received from other colleges and universities to be placed on the newsletter mailing list. This list of external organizations receiving the newsletter has already grown to several hundred.

Microcomputer Laboratory

The long-range plan identified as a major goal the philosophy that computing resources should be available at the appropriate level required to accomplish a given task. It employed four distinct levels of computing using microcomputers, minicomputers, maxicomputers, and computers at other distant colleges (EDUNET).

Because microcomputers were determined to be particularly important for the future, a Microcomputer Laboratory was planned. The objective of this lab was to address the "chicken and egg" syndrome which had existed prior to the plan. It hopefully would be a place for faculty to feel, touch, see, and test each of the most popular microcomputers on the market. This lab has a rich inventory of available software developed at other locations throughout the country and a budget enabling faculty to request the acquisition of a particular package so that he or she can examine possibilities for classroom introduction.

Benefits

There have been many benefits from both the Memorandum of Opinion policy and the Long-Range Computer Services Master Plan. The formal review process has resulted in an increased awareness on the part of the departments for planning. Several academic departments have developed long-range plans for the first time. The Secretarial Science Department's Plan called for a whole new curriculum, including a new department name — Office Technologies. Because of this increased focus on planning, the departments are finding it easier to get the resources they need to carry out their respective missions.

A second area of benefit is campus-wide compatibility for interconnection to the mini-and maxicomputers on campus, as well as to the computing resources available through the national educational computer network — EDUNET. Numerous spin-off benefits result from campus-wide compatibility including ease in problem determination of a complex network and ease in coordinating hardware and software maintenance activities. Finally, the overall institutional planning seems to be enhanced because of the institutional awareness of "what's happening" at the department levels. This has even occurred for items often times not previously considered to be computer related.

This new focus on planning within the instutition has also resulted in the creation of a new Office of Planning. One of the most recent accomplishments of the Office of Planning with the assistance of Computer Services has been to computerize the goals and objectives of all areas in the institution.

In summary, the benefits of the Long Range Computer Services Master Plan seems to even the casual observer to be numerous and far reaching within the institution. It certainly has been most effective in the areas of computing and information systems. It probably has been most effective in enabling the institution to do better overall planning. This has resulted in an institution which has become more successful in carrying out its overall mission, philosophy and goals.

Future

The future for developing a computer literate faculty at College of DuPage is very bright. College of DuPage is very fortunate to have an excellent faculty, administrative, and support staff. In addition, there is a climate of excitement among the academic departments as the faculty continue to prepare for the future by expanding their computer literacy.

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Access to Specialized Resources Through Microcomputers

Karl L. Zinn, University of Michigan — Ann Arbor

INTRODUCTION

The subject of this session concerns access to specialized resources for teaching and research. My topic is microcomputers and the special software and application programs used with them. I would like to call attention to the microcomputer and its uses as a very "ordinary" resource in the future as contrasted with the special attention given it today. We should be anticipating a time when nearly all college students and faculty members do computing and handle information in a familiar and personal way (Zinn, 1980).

The dramatic growth of a small computer industry in the 70's and particularly the attention given to the least expensive machines since 1975 make new opportunities available for personalized computing. (See Appendix A and the bibliography for this chapter.) Recently High/Scope Foundation and the University of Michigan established a project called "Dataspan" to assist science teachers in selecting and using small computers. We intend to help link local service centers with national resource networks in such a way that our brief project can disappear and beneficial communication continue.

The Center for Research on Learning and Teaching at the University of Michigan has had a role in the development of all of these technologies. However, we are a group of resident consultants, rather than a typical learning resource center with operational goals and budget. We help along developments in the regular service units and in various academic units. Many topics with which CRLT deals bear on faculty access to specialized resources for instruction.

At its simplest level CONFER (Zinn, et. al, 1976) may be viewed as a combination of an electronic bulletin board with electronic mail. One of the benefits I most enjoy is effective use of distributed expertise (Zinn, 1977). Dataspan (Zinn and Banet, 1980) is at the moment a list of ideas for data sharing and a skeleton of the resource guides and other advice needed by local experts. We are working with the network of instructional computing experts in southeastern Michigan, and are seeking help throughout the national resource networks. At this stage we are actively seeking resources and advice. Next summer we will have the first resource packages ready to go out to remote field test sites.

Perspective on Personal Use of Computers

When planning for personal computer use, one should consider the personal aids students now have in their residences and communities. This exercise helps to maintain perspective on the requirements for effective personal use of computers.

A personal typewriter is available on demand. A portable one is carried to the library, a carrel, and outside on the lawn. Consider the frustration some people experience when they have to type a report on an unfamiliar machine. Sometimes the preferred typewriter is shared, but conflicts do develop, and a personal machine is preferred. Some students get along using a "public" typewriter located in the library or other central location. However, these machines seem to break down when most needed. A few students regularly depend on others to do their typing, and nearly all students occasionally call on special production services, either commercial or non profit. Personal typing is only a small part of potential personal computer use, but typical experiences of students with typewriters and reproduction is illuminating and helps set some guidelines for planning regarding microcomputers.

Most college residences now have personal telephones. Students gain a unique identifier or address this way. Telephone communication is much more useful than mail in personal and academic communication, and a single phone on the hall just won't do any more. The medium is there when you want it, although getting no answer or a busy signal, being wakened from a sound sleep when someone else needs to talk to you, are continuous problems with personal phones. However, the storage feature of digital and audio communication services, combined with personal computers, could solve this kind of problem.

Students have individual writing desks, with the supplies and shelf storage arranged according to personal preference. The desk in ones residence or carrel in a shared working area provides a situation for study and scholarly work. I do my best work when I have my accustomed supplies at hand, access to notes and previous reports, and am in my familiar place of work. I expect that a portable, personal computer — which can retrieve and use information stored at other sites and communicate with colleagues through electronic mail — will help me to carry some of that familiar working situation with me wherever I go, much more than presently with a portable terminal.

Entertainment and recreation are personalized now through pocket radios, audio cassette recorders, and portable stereo systems. Even video cassette recorders and videodiscs are not uncommon in student rooms. It is instructive to talk with students about what they are willing to pay for personal equipment, and what they expect it to do for them. Enough students how have personal computers for recreational and hobbyist activities that some can comment on computer acquisitions directly. The combination of videodisc (for storage of digital as well as video information) with personal computers has great potential.

Libraries and bookstores are personalized in interesting ways also. Browsing is encouraged in some and is more common than systematic retrieval of documents. Personalized advice from staff is evident in the preferred book stores, and advice from peers is common and sometimes preferred to staff assistance. Information services accessed by personal computers should try to accommodate browsing, personalized advice, and peer discussions.

Communication aids for handicapped students may be the most significant contribution of microcomputers to education in this decade. Those with impaired sight or hearing find significant supplements and other aids in personalized microcomputer systems. And those with severe handicaps restricting voice, writing, or memory find the new technologies can give them vocal communication, composition aids, or help with organization of notes. The experience of a student in a University of Michigan extension course illustrates this potential.

Jim came to class in a wheel chair without voice or keyboard to communicate. He now carries on his chair a personal computer which provides spoken voice and text display, and it allows him to enter, organize and retrieve information for commuication, study and professional work. Already a good computer programmer, some day he will be an excellent system designer. This is another success of an exceptional laboratory at Michigan State University, under the direction of John Eulenberg, which creates communication aids for the severely handicapped.

Jim carries his personal computer with him on his battery-powered wheel chair. So his computer also needs to take its power from the battery and be rugged enough to handle the range of temperatures and moisture wherever he goes. It needs a large memory to store the vocabulary of words and phrases he would like to speak, as well as computer programs for personal convenience, and information to have at hand.

A voice synthesizer has been added to the computer so that whatever Jim wants to say can be spoken by the machine. He assembles words and phrases, directing his computer with a foot pedal, since that's the part of his body over which he has good control. The text of what he wants to say appears on a small screen mounted on the arm of his wheelchair. When it's right, and when he has the attention of his listener, he directs the computer to speak, at a normal rate, the entire utterance. It might be just "How are you?" or it could be the speech for a national conference on communication aids for handicappers.

An important point to make is that the same electronics technology that helps us communicate for pleasure or for business may be a necessity for somene who has been denied some basic medium of communication such as speech. But further, and this is more subtle, what is learned from helping those with severe handicaps often can be applied to helping the rest of us with our minor handicaps.

Getting started at one university

Experiences at the University of Michigan, and elsewhere in the state, trying to improve access to small computer equipment, software, application programs, data bases, and technical assistance may be useful to others attempting to use microcomputers as specialized resources for teaching and research.

Lacking the budget for purchase, CRLT convinced a local store to lease small computers to the University. CRLT paid the maintenance and insurance as well as lease charges from a revolving account and passed the costs on to the users. The rental pool began with Commodore PET's in October 1978 and added Apples in February of 1979. It helped people get started without having to make a commitment to purchase. If they decided on keeping the equipment, half the rental payments could be applied toward purchase. The pool also helped handle "seasonal" needs, e.g., getting 20 microcomputers into a lab for just those times during the semester when all the students need to be working with them.

The Mechanical Engineering Department in the College of Engineering at the University of Michigan was the first to establish a purchase incentive for individual faculty members. A revolving account was set up with about $500 for each member of the department to spend on a personal-professional computer owned by the University but assigned to the individual. Recommended machines were $900 to $1700 and the difference could be made up by donations to the account. Tax credits in the state as well as deductions from income for federal tax made faculty contributions to the program even easier. (Imagine getting personal use of a $1300 computer for $280!) The program has worked, since every member of the department now uses a personal computer regularly and many of the machines are available in labs and offices for student use as well. Faculty members who avoided the large timesharing system now use it regularly, perhaps because of an easier introduction to computing through friendly and personal small machines. Some of the users of big computers who previously shunned the little machines now use them in appropriate ways.

The Engineering Library placed stand-alone machines in a student workroom among the terminals used on the timesharing system. In the classroom buildings, labs have been established not just for set courses but for general student use. Support services have been established by the Computing Center especially for shared uses such as communication between microcomputers and the timesharing system by direct telephone connection or compatible disk drives. A special project exploring campus networks is considering the role of personal machines along with those being acquired by departments which need to be hooked up to the timesharing service. The goal is a general communication network which will be helpful to all computer users. Some individual offices (among them the Center for Research on Learning and Teaching) are assembling data bases and program libraries on the academic timesharing system for personal computer users. But all this work still does not put personal machines in the hands of most students.

CRLT would like to have more influence on commercial sources since that is how computing is likely to be provided to all students. The rental program in Ann Arbor has been extended to students on a trial basis. Now we would like to see support services, perhaps in cooperation with bookstores: specialized software, fancy printers, and the like. The Source and Micronet have advertised extensive educational software and data bases which will be available to students, and we keep watch as users of these national systems. I expect that something far more extensive and helpful than the "College Outline Series" of the 50's and 60's will be delivered by national network to personal computers on U.S. campuses before the end of the 80's.

Prospects for the Future

Commodore, Atari, Radio Shack, Apple and other computer companies first tried the entertainment and hobbyist markets, then were successful with professional and small business buyers. They made another attempt in the broad consumer market with the least expensive ($300) machines (small, with color TV, games cartridges, and only pseudo-professional applications). Manufacturers are doing market research on how much students will pay for what products. I expect a push to sell to students after the more lucrative professional market is partly satisfied. They will probably turn to the student market with a word processing and note handling system for about $1000. Eventually the personal electric typewriter (about $300) will have to become electronic in order to save on production costs and maintenance, and at that time the microprocessor and memory will be additions of modest price.

Already the new wave of programmable calculators such as Sharp (distributed by Radio Shack in this country) have become established products, and the desk top models by Hewlett Packard, NEC, and Casio have a good chance too. Japanese manufacturers have plans for a significant new introduction about 1985. The future is bright for personal computers as educational resources.

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Appendix A: Uses of Microcomputers in teaching at the Univeristy of Michigan

Aerospace Engineering

Instruction about graphics use; in data analysis and for teaching programming.

Biochemistry

Computation; lab aids.

Bioengineering

Models and simulations in teaching and research.

Center for Research on Learning and Teaching

Demonstrations and workshops for faculty; word processing, self instruction.

Chemical Engineering

Data analysis and problem solving procedures.

Chemistry

Simulation and tutorial as supplements to introductory lab.

Education

Simulation and problem solving in science teaching, math, physical education, etc.

Industrial and Operations Research

Lab activities for students.

Institute for the Study of Mental Retardation and Related Disabilities

Support functions for trainers, librarians, etc.

Institute of Public Policy Studies

Gaming research (Prisoner's Dilemma).

Mathematics

Demonstrations in numerical analysis; learning lab for remediation.

Mechanical Engineering

Computation, problem solving, simulation, communication.

Mental Health Research Institute

Math games and skills practice.

Music

Instruction in theory and composition.

Naval Architecture

Problem solving.

Pathology (Reproductive Endocrinology)

Introduction to lab instrumentation and data analysis techniques; text editing.

Physics

Simulation, problem solving.

Public Health

Simulations; models; problem solving.

Urban and Regional Planning

Simulation of decision making situations.

NOTE: Nearly all of these microcomputers also are used to communication with the academic timesharing system.

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Access to Specialized Resources for Teaching and Research in a Small University Environment

Gerald A. Knezek, Chaminade University of Honolulu

INTRODUCTION

Several factors influence an institution's ability to access specialized resources for teaching and research. Barriers to access, methods of resource identification, fund allocation strategies, and techniques for estimating the cost-effectiveness of access alternatives in a small university environment are discussed in this paper.

Great strides are being made in the availability of specialized computing resources for teaching and research. Small colleges as well as large universities can benefit from these developments. The recent experience of researchers, instructors, and managers at Chaminade University of Honolulu form the basis of ideas presented in this paper. Further details of these experiences are available through the sources listed in the references.

Barriers

Four major barriers to accessing specialized resources can be identified:

1. Lack of knowledge of available resources,
2. Inter-institutional red tape,

3. High data communication costs, and
4. Lack of financial support at potential user institutions.

The first two barriers are being overcome through the efforts of EDUCOM, EDUNET, CAUSE, and other such inter-institutional organizations, and the third barrier is being lowered by the expansion of packet-switching networks such as Telenet and TYMNET. The user can expect further reduced communication charges by as much as a factor of 5 through off-line editing with semi-intelligent and intelligent terminals such as the TI 765 and the EDUAPPLE microcomputer package. In certain cases it is even practical to eliminate communication costs altogether through dedicated applications of microcomputers. Reducing the fourth barrier, however, requires the re-education of decision makers at small colleges with respect to: (1) the true costs of supplying resources with a low volume of usage in-house and (2) the educational and political benefits to be gained from access to resources which were previously unavailable.

Actual total costs (including development time, space and maintenance charges, salary and ongoing resource allocations) of infrequently used in-house applications are often considerably higher than typical $10-$15 per hour total charges for development-free and maintenance-free remote resources. Educational benefits gained through greater access to specialized computing resources are quite obvious; political advantages related to attracting better faculty and students may be equally important.

Resource Identification

Most small college faculty members have neither the time nor the incentive to explore technological resources available to fill their needs. One practical mechanism for resource identification is the existence at a school of one or more "experts" who constantly update their knowledge of available resources. Such "experts" are usually familiar with the particular needs of most faculty, can secure more detailed information if necessary, and can sometimes arrange demonstrations of resources. For EDUNET resources, these "experts" are the EDUNET Liaison and the EDUNET Member Representative. At Chaminade, these same persons also maintain up-to-date familiarity with manufacturer offerings, CONDUIT programs, Dialog, OCLC, PLATO, the Source, and other non-profit and profit-generating resources.

Fund Allocation Strategies

Many small colleges do not have a central computing facility. Such schools regularly use service bureaus and other outside agencies for administrative operations, so access to specialized resources for teaching and research can be funded in the same manner. Federal funds have been used to initiate experimental "pilot projects" to meet a wide range of needs at Chaminade. Among these projects are Dialog, PLATO, SIGI, EIES, and numerous CAI applications. Several of these programs are being transferred to regular budgets as feasibilities are demonstrated. Others are regarded as impractical for a variety of reasons and discontinued after the pilot stage. Departmental (rather than university-wide) funding has made the trial implementation of these resources quick, inexpensive, and relatively frustration-free. Chaminade's total computing bill for experimental projects is presently less than $5000 per year.

Cost Effectiveness

Determination of the most cost-effective way to obtain access to a specialized resource is straightforward:

1. Study all practical means of access,
2. Estimate total costs under each methods,
3. Choose least expensive solution if cost differences are great; most dependable/flexible/least permanent solutions if differences are small,
4. Base estimates upon historical average costs for similar users, and
5. Check costs after trial period to verify predictions.

Experiences at Chaminade indicate that for most applications using remote resources, the initial ("pilot project") computing expenditures will be under $100. Of course, total real costs (including salaried time, amortized equipment, and supplies) will probably be greater than the amount spent on computing by a factor of 5-10 ($500-$1000), and ongoing (after implementation) cost will probably be in the range of $10-$20 per person hour devoted to the application. Nevertheless, remote access on a small scale is generally quite competitive with the true cost of developing and supporting trial applications or seldom used resources in-house. It seems only the most trivial in-house applications for teaching or research can be developed and maintained with actual costs totaling less than $1000.

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The Anatomy of a Regional Resource-Sharing Organization in North Carolina

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I. INTRODUCTION

The North Carolina Educational Computing Service (NCECS) has evolved into a regional resource-sharing organization which provides a wide variety of computer-based resources to institutions of higher learning in North Carolina. When NCECS began as a statewide computer network in 1966, its purpose was to serve as a retailer of computer time from a single "wholesale" supplier, the Triangle Universities Computation Center (TUCC). The emphasis in this paper will be on the new services and activities which have evolved over the past three or four years. The original structure and operation of the NCECS/TUCC network will be treated only briefly; these topics have been covered in papers published several years ago (1, 2).

Instead of describing NCECS in the usual computer network context, a more general approach will be used in this paper in order to facilitate comparison with other resource sharing organizations (RSO's) at a somewhat higher level of abstraction. First, the stages of NCECS development are outlined to provide an indication of chronological evolution. Then present services, especially the newer activities, are examined, with some analysis of the mutations taking place.

A division of the university system's General Administration, NCECS is the central organization for a network of 54 institutions including 13 campuses of The University of North Carolina plus the General Administration, 11 private colleges and universities, 17 community colleges and technical institutes, and 12 high schools. Network participation is voluntary, and often serves to supplement on-campus computing facilities. As a retailer of computing service, NCECS purchases machine time from TUCC and other suppliers and distributes that machine time, together with a variety of staff support services, to colleges and universities throughout the state. The traditional retail services have included training, consulting, information services, data communication facilities, etc.

In addition to acting as a supplier of computing service, NCECS offers a program of cooperative curriculum development. Activities in this area were originally funded by a 1969 grant from the National Science Foundation, and resulted in the development of a library of computer-based instructional materials in over twelve academic disciplines. Curriculum support functions are now integral to the state-funded service of NCECS, and include a regular schedule of discipline-oriented workshops to which faculty from both network and non-network institutions in North Carolina are invited. These activities are discussed in the present state of evolution in the paper by Barry Berman on developing a computer literate faculty, (see page 245), as well as in earlier papers on NCECS (1, 3).

The NCECS permanent staff now consists of thirteen positions, ten professional and three clerical. State appropriations cover about two-thirds of staff-related costs, with the remaining third coming from charges to users.

II. Expansion of Services

The addition of curriculum support services, which required four new staff positions, represented the first significant expansion of the original user service organization. It occurred in 1969, about three years before NCECS joined with four other networks to form the CONDUIT consortium (to be discussed later). These were the first services offered by the organization which were not a necessary adjunct to the provision of TUCC computer time to remote institutions.

The next expansion was in terms of machine services, and came in 1977 with the addition of other computer time suppliers. This was a natural development, since NCECS had always been separate from TUCC organizationally, thus having the potential of multiple suppliers (although for ten years only TUCC services were distributed). The addition of remote computer time suppliers involved us in two national resource sharing networks, the Health Education Network (HEN) and ECUDOM's EDUNET.

NCECS was able to become active in EDUNET during the early experimental stages because The University of North Carolina General Administration, its parent agency, had joined the EDUCOM Planning Council (the five-year project which preceeded the establishment of EDUNET as an operational network). Since EDUNET was very much in line with NCECS interests at that time, staff proposed to the Planning Council, and were funded for, a project to introduce North Carolina Network faculty to EDUNET resources. This "marketing" project was successful, and a number of accounts were opened at seven different EDUNET hosts at a time when the total number of accounts nationally was very small. From the beginning, NCECS has been a supplier to EDUNET as well as an active buyer of services provided by other network hosts. However, there has been less emphasis on our role as supplier. EDUNET is most important to NCECS as a means of providing local network users with access to specialized, often unique resources which are not available at the central facility.

During the same year, NCECS began to perform a similar function for two of the HEN hosts, with no funding for our contribution and very little in the way of concessions that would facilitate marketing of their services. During the past two years the volume of HEN medical/health CAI services supplied through NCECS has declined, while EDUNET usage has grown steadily. However, membership in HEN has been maintained because of our interest in the organization's mission and our belief in the concept of a local distributor for national network services. As the services and orientation of HEN change over time, NCECS may become a much more active participant.

The next major step was the introduction of microcomputer support services earlier this year. Two major areas of need were identified:

(1) Software to enable the microcomputer to serve as an intelligent terminal to our local hosts (in both batch and interactive modes) and to hosts on EDUNET. The EDUNET Access System (EASy) for the Apple II was one of the products developed by NCECS during the past year. It is now distributed nationally by EDUNET (a good example, incidentally, of inter-RSO cooperation).

(2) Support of stand-alone microcomputers for instructional and research applications. Due to staffing limitations much less has been done in this area; however, we are seeking grant support, and hope to be able to expand activities within the new few months. There are several aspects to the support of microcomputers used in stand-alone (as distinct from terminal) mode: information clearinghouse; training, consulting, and referral services; software/hardware testing and evaluation; software distribution; and various related functions.

With the inauguration of these services, NCECS assumes a very different role from its initial one as a state computer network providing access to a large central machine. The original function remains, however. Needs for central facility access continue, although there has been a gradual shift away from routine instructional services and toward more specialized resources, especially use of our large program library. Network institutions should be able to take an hierarchical approach to satisfying their computing requirements, an approach also appropriate for colleges and universities nationally. There are four distinct levels: microcomputers; campus facilities consisting of mainframes and/or minicomputers; the regional center (NCECS/TUCC); and the national network (EDUNET) for the most specialized resources. As a regional RSO, NCECS has a role to play at more than one level in the hierarchy — but with different types of services associated with the different levels.

Although the total volume of computer time sales may eventually decline (so far it is still growing), there is no indication that user service requirements will decrease. For this reason, staffing problems may arise in the future. NCECS must continue to offer the old services, while expanding into the new area of microcomputers. Furthermore, specialized offerings generally require more user service support than do the more routine services which are shifting to minis and micros.

III. **Present Assets of the RSO**

The various assets of the NCECS resource sharing network will now be examined. In order to expose the fundamental nature of certain changes taking place, particular attention will be given to the new microcomputer support services. Needs in this area have caused the staff to rethink NCECS' mission, and sources of funding, and have led to a broader view of its future roles as a regional RSO.

1. Large Central Computer System

This obvious asset is actually owned by the wholesaler, TUCC. When operation began, the hardware was by far the most important resource to be shared — had it not been for the high cost of computing hardware, the organization almost certainly would not have been formed. The economics and rationale that led to the establishment of regional networks in the 1960's are well known and need no elaboration here. The applications software component of the central system has grown greatly in importance over the years and will be treated as a separate asset.

RSO ASSETS

1. Large Central computer systems
   - Hardware (470 V/8, 2-370/165, 2-HP2000)
   - Operating system software
2. Data communication facilities
3. NCECS Staff (state-funded)
4. Program libraries
   - For central system access
   - For decentralized hardware
5. Links to national and other RSO's
6. Statewide network of people

2. Data Communication Facilities

The data communication network is another evident asset. Required initially to enable remote terminals throughout the state to access the central systems at TUCC, it now offers other possibilities as well. As one would expect, the network has grown more complex over the years as multiplexers have been added to accommodate interactive terminals in a network originally designed for remote batch operation. Unlike computing hardware, overall communication facility costs have not been declining, although better line utilization has been achieved as a result of time division multiplexers and high speed modems.

The communication network provides necessary data and voice links between the users and other assets, including the central staff. It can also be used for the distribution of microcomputer software via downloading. In the future, the full potential of this rather expensive resource needs to be exploited for user-to-user communications as well.

3. The NCECS Staff

User services have never been the responsibility of TUCC, so it was essential from the beginning to have a central staff to provide user support to the remote colleges and universities.

(Similar functions are performed by the campus computing centers of the three "Triangle Universities" which own TUCC.) Without a strong user service organization, the statewide network would not have been successful. With user service as the foundation, it was then possible to add other central staff services such as the cirriculum support functions mentioned earlier. Consulting on computer-based instructional materials and techniques was broad in scope, often extending beyond central system software and services. Also, it became apparent that the central staff represented a resource of *technical* information and know-how which had a value over and above the support directly associated with use of the TUCC facilities. The point is worth noting because it reveals a natural progression from direct support of the initial shared resource to much broader services, especially in the microcomputer area.

4. Program Libraries

One function of the NCECS staff has been to maintain a complete library of instructional applications (some of which are obtained from CONDUIT). This set of materials is part of a larger library of software, to which the three Triangle Universities and NCECS all have contributed. This resource now provides the principal reason why a number of network institutions continue their link to the central facility. Thus, sharing of software — the associated personnel investment — has become more important to many users than availability of central system hardware per se.

However, centralized software acquisition, development, maintenance, and documentation also are appropriate when hardware is distributed. The Minnesota Educational Computing Consortium (MECC) implemented such a plan at least two years ago (4, 5). Thus, NCECS is moving toward a second program library, consisting of microcomputer software which can be downloaded (or otherwise distributed) to campus machines.

5. Relationships with other RSO's

Participation in EDUNET and HEN has already been discussed. There are a few other suppliers of specialized services: The Chapel Hill campus of The University of North Carolina for a medical CAI service, Dartmouth College (originally, but not presently, an EDUNET supplier), the Research Library Information Network (RLIN), and one of our own network institutions, The University of North Carolina at Greensboro, for an academic time-sharing service to be offered off-campus in 1981. NCECS is one of nine RSO's being studied under an NSF grant to EDUCOM, and it is unique in having member or customer relationships with five of the remaining eight (6).

Our links to national RSO's have not been limited to computer time suppliers, however. The most important such relationship has been the one with CONDUIT (see paper by James Johnson, page 297). As one of the founders, NCECS has been very much involved in that RSO from the start. (CONDUIT is an RSO spawned by other RSO's, namely regional networks.) It is now our most important source of instructional software. Some of CONDUIT products installed on the machines at TUCC may be by EDUNET users (typically for trial usage); two national RSO's are thus bridged. CONDUIT and EDUNET are in general complementary, because in one case the software is disseminated for local implementation and in the other case it is accessed at originating host facility.

As a regional representative of CONDUIT, NCECS has distributed much of their information over the years, and there is a widespread awareness of that RSO throughout the state. We now order and redistribute CONDUIT software for implementation on campus machines as well as providing access to it at TUCC. There is much to be gained through cooperation between NCECS and CONDUIT, both of which are now responding to rapidly growing user demands for software and information related to microcomputers. CONDUIT moved into microcomputing before NCECS did, and definitely influenced us in that regard.

NCECS acts as a local distributor for the services of the RSO's mentioned above. The functions include marketing and locating resources, first-line user service, account initiation, billing and related support services. This arrangement has proved an effective way of creating awareness among network faculty and broadly disseminating the national RSO's services. The information dissemination function is especially significant, and will become more important in the future.

6. The people (user) network

As with many other RSO's, the network of people has come about as a by-product of network operations, and now constitutes an important asset — one which we do not want to see disintegrate as a result of distributed hardware. For many years NCECS has made use of the discipline-specific knowledge of network faculty by using them as workshop speakers, as reviewers of computer-based curricular materials (mainly non-CONDUIT materials) and as general resource persons in their academic fields. Some users have developed instructional software which was added to the public library on the central system (and, in some cases, later adopted by CONDUIT). At one time the network had formal committees in the various academic disciplines, but the trend has been to rely more on CONDUIT's nationally-based committees and peer review process.

With the advent of microcomputers, there is a new requirement to share the technical (as distinct from discipline-based) knowledge of our network faculty. There is a general need to share the very large effort required to stay current in the rapidly developing microcomputer arena. NCECS is now able to provide a nucleus of technical expertise, but the proliferation of microcomputer systems and peripheral hardware and software products, from a variety of small and often unknown companies, is such that our central staff cannot be expert in all areas. Several different microcomputers must be supported, and subcommunities are already developing within the network (as well as nationally) around particular machines such as the Apple II, TRS-80, and PET. It is therefore desirable to have a mechanism for sharing the knowledge of experienced microcomputer users in the network, as a means of augmenting the central staff and controlling their consulting workload. Similar needs exist for sharing user-developed and user-collected software.

VI. **Conclusions**

The evolution of NCECS as a broadly based regional RSO embraces a transition from distributing computer time and related support services — initially from one supplier and later from many — to serving as a central clearinghouse for the exchange of information and software not directly related to any central or remote host computer facilities. The use of network communication facilities to accomplish the direct exchange of information and software between microcomputer users constitutes a fundamentally different role for a regional network established to provide access to a central computer. In the past, inter-institution user-to-user communication has generally been limited to meetings and workshops. However, sharing between users, utilizing computer-based conferencing systems, is already common in some microcomputer communities (and elsewhere) and NCECS must now develop similar capabilities (8, 9). Computer-based conferencing is a way of using the technology to automate, at least partially, the information exchange process.

The projected model thus includes distributed technical expertise, with a sharing mechanism, as well as distributed hardware. This contrasts with the original model, where the central staff was expected to possess complete knowledge of essentially all hardware/software facilities. Thus, NCECS becomes a vehicle for general information exchange rather than continuing as a sole source of technical knowledge for a more limited set of resources. Contributions to the clearinghouse information base should come from users, central staff and remote resource centers (with the RSO staff performing a sifting function).

RSO's typically yield the leverage that comes from a central organization distributing services to a multiple-institution user community, in this case a statewide network of computer users. However, NCECS derives additional leverage, on the input side, from its links with national RSO's. Some of these organizations might not otherwise be known to the smaller (or even some of the larger) institutions in our network. Local capabilities are amplified substantially by the ability to draw upon the resources of RSO's such as CONDUIT and EDUNET — especially when such national RSO's in turn represent a large base of developers and suppliers. Microcomputer-related activities are now involving us with some interesting new ROS's, university projects, and user communities, sometimes through computer-based conferencing.

We believe most of the microcomputer-related functions being implemented by NCECS, plus the relationships with national networks such as EDUNET, are appropriate for many other regional and statewide computer networks around the country. A few, following the example of MECC, are already introducing central staff support for microcomputers. New state networks may, in fact, be estabished just to perform facilitating functions, with no requirement to provide service from a central computer facility (10). For existing networks, the challenge will be to adapt to the new realities of distributed computing — as a matter of survival.

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CONDUIT — A National Resource-Sharing Organization

James W. Johnson, CONDUIT

Resource Sharing Organizations — A Precarious Position

There is really nothing unique about resource sharing. In the purest sense every time we buy a Fortran compiler or a statistical package or a computer we are sharing resources by spreading development costs over several users. Obvious items for resource sharing are those that have a high development cost such as software, or a low reproduction cost such as information.

A characteristic of non-profit resource sharing organizations is that they exist because a need is not being fulfilled by other groups in our society. Usually the need is not being met by the private market system because the market for services or products to meet that need is too small, too specialized, too diffused or too poor. The need isn't being met by individuals because products are too expensive to develop or too specialized.

These economic considerations create some interesting, if not insurmountable, problems for non-profit resource sharing organizations. First, they deal with items or services that have high development cost, but they typically have little or no capital for development. Second, they deal with products that are relatively easy to reproduce so they are difficult to protect and rarely produce returns. Third, they deal with items that, because of the size of the market, are unprofitable and because of high initial cost, uneconomical.

For these reasons, resource sharing organizations such as CONDUIT depend on initial capital usually in the from of a grant, on goodwill of users to support an idea as well as a product, and on revenue from services.

These points are well illustrated by the CONDUIT experience.

CONDUIT History

Stimulated by a deep concern about the lack of sharing of computer-based instructional ideas, five regional computer centers joined together in 1971 to form CONDUIT (**C**omputers at **O**regon State, **N**orth Carolina Educational Computing Service, **D**artmouth College, and the **U**niversities of **I**owa and **T**exas at Austin). CONDUIT received support from the National Science Foundation to conduct a three-year experiment to identify ways of eliminating barriers to the widespread use of computing materials.

During the first two years over 250 college instructors participated in workshops and in monitored classroom tests. Almost 3,000 students used computer-based instructional materials selected by panels of experts and imported from other schools. The test revealed serious shortcomings in the design and documentation of existing materials.

The third year of the experiment attacked the difficult task of evaluating results and testing possible solutions. Some major conclusions were that:

- — Instructors are favorable toward the use of instructional computing, largely because they see it as an essential tool for their subject;
- — Student attitudes are positive toward computing, but they fear technical details;

- Transfer of existing materials from the originating location is costly and risky; and
- Transfer costs risks can be reduced by using standards for design and documentation and by reviewing materials before they are imported.

Encouraged by these results, CONDUIT proposed a system for the collection, evaluation and dissemination of instructional materials for use in higher education. Funding support to develop the prototype system was received from the National Science Foundation in 1975 with additional support from the EXXON Educational Foundation in 1977.

Organization Products

Today CONDUIT has three major roles: a source of computer-based instructional materials, a research and development center, and an information resource.

The distribution of reviewed, tested and packaged instructional materials for higher education is the backbone of the organization and constitutes over one-half of its activity. Over 100 packages are listed in the CONDUIT catalog. They have been sent to schools, individuals and institutions in every state, and about 12 countries outside of the U.S. They have been translated into Spanish, German, Italian, French, and Norwegian. The bulk of the recipients are at small colleges with a heavy emphasis on instruction. They are used because they improve instruction by offering aid and experiences not possible without computing.

The materials come in two categories: standard packages that fit a large cross-section of computer equipment such as IBM, CDC, and DEC and microcomputer versions tailored for PET's, TR-80's, and Apple II's. A key point is that our mission is to improve instruction so we distribute our materials to anyone; we do not restrict distribution to members or subscribers.

The research and development activity is focused on microcomputers. Here CONDUIT is looking at the unique characteristics of microprocessor-based systems such as color graphic display, tone generation, and analog input as they relate to instructional materials. Major funding for this effort has been received by the National Science Foundation. CONDUIT is also converting several of its older standard packages to microcomputer-based system. This effort is supported by the Fund for the Improvement of Post-Secondary Education (FIPSE). In addition, the development of authoring tools to reduce the cost of package production and the promotionalization of standards are a major project activity.

Perhaps the most important role of our resource sharing organization is the transfer of information. CONDUIT produces a glossy publication, the *PIPELINE*, that contains information about the project and instructional computing in general. CONDUIT also publishes a report on the status of computing in undergraduate education based on extensive surveys in biology, chemistry, geography, management sciences, mathematics, physics, political science, psychology, and sociology. To assist developers, CONDUIT has prepared two manuals: *Author's Guide: How to Design, Develop and Package Instructional Materials for Widespread Distribution*, and *BASIC Guide* (for writing and transferring programs written in BASIC).

Each of these areas, materials, research and development, and information distribution combine to constitute the total CONDUIT effort.

Support Strategy

As suggested earlier, a resource sharing organization is always on the edge of economic failure. The CONDUIT strategy for support consists of revenue from: (1) sales of materials, (2) memberships and subscriptions, and (3) grants for research and development. These efforts are not exclusive in that distribution of materials is not limited to members and subscribers. Members and subscribers are often institutions that wish to support the CONDUIT because they believe in its worth and because of the value of information produced. This multiple support base can produce conflicts if the needs of members are different from those of purchasers and granting agencies. For example, funding agencies may be interested in projects that produce information of national interest, purchasers may be interested in materials that will help them immediately in instruction, and members may be interested in reducing personnel costs by shared effort. Pulls in different directions can be disastrous to a resource sharing organization.

Another element in the support picture is the contribution of the University of Iowa in providing space and computing facilities for the organization. Here a careful line must be drawn between national needs and solely local needs. The line has been maintained well because of the goodwill between CONDUIT members and the University Administration. The CONDUIT policy board and the funding agencies provide mechanisms for resolving conflicts if they should develop.

Conclusion — The Importance of a Mission

Because of the precarious existence of resource sharing organizations and the potential for conflict between different constituencies, it is very important to develop a mission that is clearly understood. The mission must state the need that is going to be fulfilled and for whom it is going to be fulfilled. The question of exactly how the need is going to be met may change over time, but it too must be clearly understood.

The reasons for a well understood and relatively rigid mission are several:

- It focuses limited resources.
- It helps the organization resist demands for services that are not part of the mission.
- It helps keep the organization from engaging in activities based solely on profitability.
- It reduces the problems of a multiple constituency.

The CONDUIT experience has shown that with a clear mission, a resource sharing organization can provide needed services. Perhaps of greatest importance is the fact that a strong sense of mission can help elicit the high level of commitment of people that is necessary for survival.

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How To Deliver Low-Cost Computing Throughout the University

Clair G. Maple, Iowa State University

Introduction

The Computation Center in Iowa State University (ISU) has an AS/6 for research and instructional computing and a pair of PDP11/780 VAX computers for instructional interactive computing which satisfy most of the campus needs for academic computing. However, during the past decade there has been a tremendous influx of minis and micros on campus which raised the question among the staff of the Computation Center as to the proper role such devices should play in the development of educational technology of the University. After some deliberation the Computation Center, with the co-operation of the Electrical Engineering Department, started development of a local communications network of minis and micros to provide a distributed computing facility for use by research and instructional laboratories on the campus. In 1976, the National Science Foundation gave ISU a three-year grant to develop a support

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group and enhance the simplicity and ease of use of the network. This group was not only instrumental in the success of the network but also later became the Center's team to support the use of micros. The network, now known as the ISU Datanet, was designed to meet the computing needs of the inexpert user through the combined use of personal computers and a well-established operating system. One of the primary objectives was to minimize the software requirements and operating costs for the user.

The Communications Net

The Datanet was designed to provide communications facilities to support access to storage and needed software systems. In structure, the Datanet is a ring with a trunk of coaxial cable, about a mile long, that runs between buildings on the campus in underground steam tunnels and conduits. The signals on this ring are circulated at an effective rate of 3.088 megahertz with regeneration taking place each time they pass through a station interface. The circulating information is carried in 256 slots of 12 bits each. Two of the slots are reserved: slot number 255 carries a synchronization pulse, and slot 0 contains line status information. The remaining 254 slots are available to be used by specific stations. Each station has the capability of receiving information from one or two slot positions which are spaced at least 64 slots apart. The ring has a theoretical capacity of 254 one-way conversations at 1200 bps.

The line is serviced by basically two types of hardware stations. One type is called a central station (CS) which is capable of station-to-station communication on a first-come, first-served basis. The other type is called a centrally communicating station (CCS), capable only of connecting a device to a specified central facility for dedicated two-way communication.

A central station consists of a battery-backed repeater for detecting the signal coming from the trunk line to the next station. In addition, a CS contains an interface unit and an Intel

SBC 80/10 microcomputer. The interface unit executes all of the time-critical line protocol and error-handling functions automatically in 0.3 microseconds. All of the standard slower functions are implemented in software on a Z80. If a faster equivalent micro is needed, a Z80 may be replaced by a Z80B — a 6 megahertz microcomputer.

The centrally communicating station consists of a repeater and a reduced interface including eight universal asynchronous receiver transmitter (UART) ports. These eight ports share a single send slot and a single receive slot which are time-multiplexed so that each UART has access to the designated slot every ninth revolution of the byte train. Each port has a maximum bit rate of 1200 bps and is timed from the line. Optionally, the ports may operate at 600, 300, 150, and 110 bps. When a port does not have a character to send into the line a HOLD is automatically inserted. The send and receive slots used by the ports are totally dedicated to this use and are not available to general purpose devices directly.

In addition to the two types of stations described above, there is a modification of a central station called a master station which provides the clocking, error logging, automatic shutdown on accumulation of 256 errors, and other housekeeping chores associated with the maintenance of the ring.

The central stations communicate by means of packet transmission in which one byte of the packet is transmitted with each revolution of the slot train. Access to a slot assigned to a specific receiving station is on a first-come, first-served basis and, once obtained, access rights can be maintained by inserting HOLDs or valid characters. This permits use of the variable length packet format in which the header information is followed by a sequence of valid characters and HOLDs for an indefinite length, which in turn are followed by a termination flag. However, if a character or HOLD is not inserted into a slot on each consecutive revolution, then that slot reverts to an IDLE status and becomes available to other stations.

The Central Facility

The central computer that is associated with the Datanet is a PDP 11/34 with 96K bytes of main memory and 120 megabytes of disk storage. The PDP operates under the UNIX (a Bell Telephone Laboratory trademark) operating system. This computer is connected to the communications loop via a standard DR-11C general-purpose interface on the PDP and special software in the central station. In addition, the PDP 11/34 can appear as a WYLBUR terminal attached to the AS/6. This gives the Datanet user access to the facilities of the AS/6 via the job submittal feature of WYLBUR while working at his Datanet station.

The Software

The software in the central station consists of a colletion of service routines that are activated by interrupts generated by the interface which assigns one of three levels of priority. The highest level of priority is assigned to the control characters coming from the line while the next level is given over to the transmission of data onto the line. Interrupts which service the parallel and serial ports have been assigned the lowest priority.

There are three types of interrupts which occur in the flow of data from the line to the receiving station. The FLAG service routine resets the slot counter that is used to determine which port at the CCS currently owns the slot. A HOLD character on the slot acts as a place-holder and indicates the absence of data No action is taken other than to increment the slot counter. If data are received, the data byte and a slot identification number are appended to the input queue of the outgoing parallel ports and the output interrupt is enabled. When the parallel port generates an output buffer empty interrupt, the interface will activate a third service routine that removes the data byte and the slot identification number from the head of the queue and sends it to the output buffer.

The central station may service two CCs and each of these in turn may service eight terminals which can operate at two select-able baud rates. The transmission rate for each terminal is stored in a table in the central station. This table contains the number of revolutions of the terminal slot that must be skipped between times that the terminal can accept data. When a data byte is put onto a slot, the baud rate table is consulted and a slot revolution counter is activated. HQLDs are placed onto the slot until the counter indicates that the slot is again ready to accept data. The data which are to be sent to a CCS terminal are received on a demand basis from the system that is attached to the parallel ports. Each terminal has its own queue that holds the date bytes the terminal will receive. When the queue is less than half full, the transmit routine places a request to send the next data byte for that terminal into the parallel port output queue.

The Services

One of the principal considerations in the construction of the high-speed Datanet was the way in which we might provide to the researcher with a microcomputer in his laboratory access to central computing facilities. Toward this end, we selected the Commodore PET as the microcomputer that we would support from both hardware and software points of view. PET can be used as a terminal on UNIX, as a stand-alone personal computer, or as a stand-alone device that has extended disk storage capacity via the Datanet. These multiple uses for the PET have been made possible through the local development of an IEEE 488 to RS232C adapter and a communications software program for the PET known locally as "netcom" — a program that automatically handles the necessary protocol with UNIX.

A variety of other aids that are helpful to the use of other microcomputers are provided via the Datanet. These include cross-assemblers for the Intel 8080 and 8085, the Zilog Z80, and the MOS Technology 6502. In addition, a language known as PORTAL, which has many of the characteristics associated with the C language, has been developed locally so that systems software for microcomputers can be written in a high-level language, with object code loaded directly into the microcomputer.

The Uses

A number of research projects are currently making use of the facilities provided by the Datanet. For example, a turbomachinery laboratory has been automated to make use of both the Datanet and the communications link to the AS/6. In this low-speed compressor study, the PET is used to control a probe insertion into the flow stream and the clock to determine the sample rate of data collection. The output of several thermocouples, pressure transducers, and other such instruments are sampled by an HP 3495A scanner controlled by the PET. The data collected are initially stored on both the Datanet disk facility and the cassette tape of the PET to be sure that there is backup data available. Later, the data are recalled and reduced by the PET before they are sent to an AS/6-accessible data set. The AS/6 is then used to process the data, and it presents results in graphical form on a Simplotter.

A second example is taken from a project in veterinary physiology and pharmacology, a project typical of the way in which microcomputers are beginning to be used on the campus. Animal instrumentation produces a number of analog signals which are proportional to the respiratory variables of pressure, tidal volume, and flow. The analog signals are digitized with a locally-designed PET A/D and D/A system and then processed by a BASIC program in the PET to yield derived parameters. Instantaneous analysis gives the researcher the opportunity to make judgments as to the validity of the experiment in progress and then to proceed or discontinue the work. Printout of experimental data is accomplished at the end of a successful experiement on the PET.

In addition to the type of use indicated by the above two examples, there are a significant number of individuals using the PET or APPLE microcomputers in a stand-alone mode. In several instances they use the Datanet to download programs to their computers or to transfer data from their own cassette to the PDP 11/34; or, alternatively, if the micro is equipped with a communications module, it may be used as a terminal to the Itel AS/6 that also has the ability to upload or download data or programs. This type of use is illustrated in the implementation of a data collection system making use of an analog-to-digital converter developed by the Microsupport Group. The data collection system is being used remotely in confinement feeding sites for livestock. Environmental data are collected from actuators used to control fans, heaters, and similar devices. These are processed in real time on a PET. In addition to fulfilling control functions, the PET also serves as a general-purpose logging device. The entire effort makes extensive use of the cross-assemblers available via the Datanet from which object code is directly downloaded into the PET.

Overall, there are some fifteen or sixteen projects on the campus using microcomputers and/or the Datanet facilities. Approximately half of these are engineering-oriented; the rest are spread around the campus in such areas as economics, psychology, food technology, zoology, entomology, political science, and veterinary medicine.

The Management of the Datanet

As mentioned earlier, the work on this facility was partially supported by the National Science Foundation. The support was in the form of a three-year grant that expired in November 1979. At that time the Computation Center took over support and management of the Datanet and the microcomputer activities. The Datanet is made available to users 24 hours a day, 7 days a week, with only occasional down times for maintenance or modification. For the past year, records show that the UNIX system is being used at a rate of approximately 500 sessions per month.

Four persons are staffing the Datanet and general micro activities. The project is managed by an Associate Professor of Electrical Engineering who devotes five-eighths of his time to it. There is one part-time technician who maintains the Datanet and the personal computers. In addition, there is one full-time engineer and one full-time software programmer. They offer advice and assistance to members of the faculty and staff with related computing needs.

During the period of the NSF grant, these services were offered without charge. To support these activities after termination of the grant, a charging system has been implemented for each connection made to the Datanet. Equipment is now available on a rental basis. Fees are usually set in order to recover the cost of maintenance and the amortization of the equipment being used. Current rental and maintenance charges for personal computers are set at $50 per month for the PET, $75 per month for the TRS 80, and $100 per month for the Apple. There is a $25 per month charge for a hardwired port and $12.50 per month for a dial-up port. At this stage, the activities are not yet self-supporting; so the Computation Center and, in turn, the University are currently subsidizing them. Although it is hoped that at some stage the services will become self-supporting, their existence is not dependent on it. The University has always supported research; and, given the rapid increase of microcomputers and the significant contributions they are making, this is one area where there are likely to be excellent returns.

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27

CABLE OR PACKETS
Is it Necessary to Choose?

Richard Cogger, Cornell University

At Cornell, the last few years have seen an accelerated growth in the use of interactive computing and in the consequent need to provide communications between user terminals and the computing resources they use. Ten years ago, users dialed in using the traditional telephone system with acoustic couplers. Then because of the higher speed (1200 Bps) available, leased phone lines began to dominate. These leased lines were inexpensive enough and the terminals were sufficiently dispersed that multiplexing offered no substantial economy. However, the costs of data communication were growing linearly with the number of terminals. Given this background, the stage was set as of about three years ago to consider implementation of some form of local communications network.

The following is an interim report on the evolving considerations behind the implementation of data communications facilities, including some local networking, on the Cornell Campus. The ideas and opinions are the current thinking of the author, but Cornell's decision process has not reached a conclusion, and no large-scale commitment to a particular form of local network design has been made.

The Concept of a Local Network

Figure 1 presents a simplified diagram to illustrate the major uses which a local communications net might support. As shown, the network occupies a central position, providing an interface between computing users and computing resources. In its simplest form, the primary purpose of a network is the interconnection of user-terminals with host computers; secondary purposes are the provision of channels between computers and interfacing via public data networks to remote users and computers. The motivation for creating such a network can be seen as economic or as a means of providing a greater selection of facilities to campus users; significant advances in both areas are possible.

Reasons for a Local Network

Without some organized approach to data communications, the coming era of rapid growth in the deployment of user terminals will present substantial problems in the management and use of computing facilities. The promise of reducing these difficulties constitutes an important rationale for building a network:

1. The budget for connection of a terminal to a computer by traditional means would have approximately the following content:

Share of Communications Front End	$30/mo.
Two Modems (1200-baud)	30
Telephone Leased Line (4-wire)	30
	$90/mo.

In times when a university might support fifty or even a hundred terminals, such costs were not staggering. Looking ahead to a need for support of several thousand terminals, these costs become very large. And they can not be expected to decline:

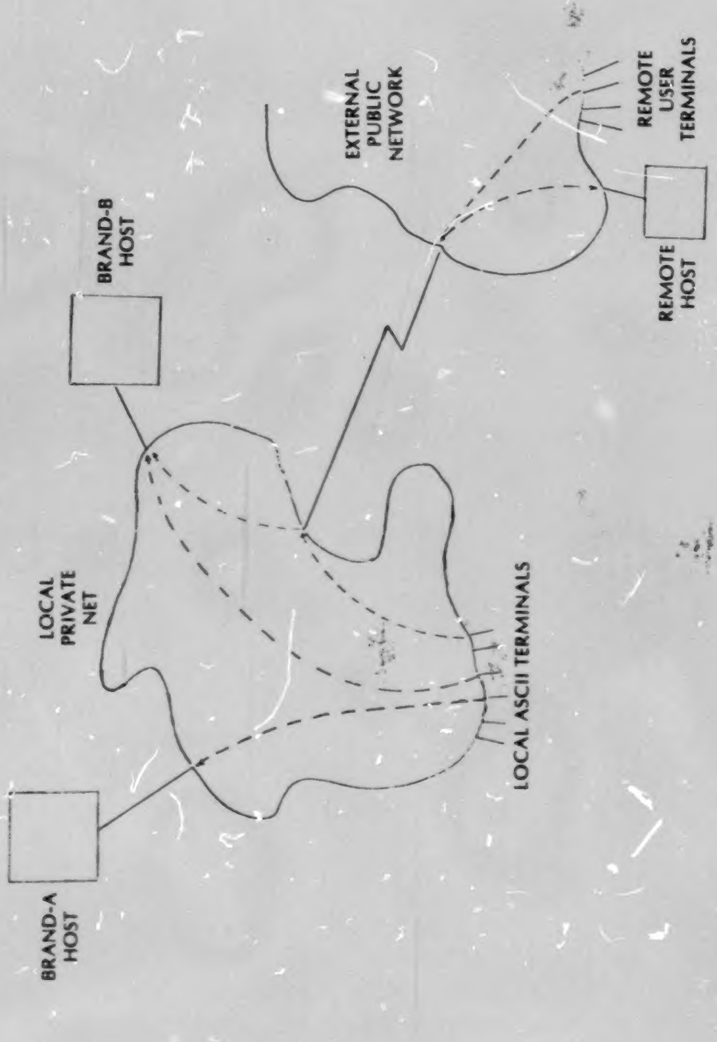
BRAND-A HOST
LOCAL PRIVATE NET
BRAND-B HOST
EXTERNAL PUBLIC NETWORK
LOCAL ASCII TERMINALS
REMOTE HOST
REMOTE USER TERMINALS

FIGURE 1. LOCAL NETWORK

new technology will reduce the cost of modems and of the host front-end, but costs for telephone-company circuits will continue to rise. Of course, the phone company may eventually provide a solution within their system, but it does not appear likely to arrive in a timely manner. Probably the greatest problem with these costs is that they are concentrated in elements which occur once per terminal and are therefore largely immune to economies of scale.

2. If a terminal is directly wired to a single computer, the user has only that one resource available. A means of switching is needed.

3. A significant management problem exists because of the need to consider the attachment of terminals to each new unit of computing resource which is acquired. Cornell is diverse in many ways, and the acquisition of computing resources is unlikely to be centrally controlled in its entirety. Certainly the acquisition of terminals is the result of widely distributed decision processes. A means is therefore needed to decouple growth in terminal population from acquisition of computers. A user acquiring a terminal today should be able to rely on access to new computing capacity as it is acquired, and without disruption. Ideally, a network can be seen as a flexible and distributed front-end processor which grows as does the terminal population and which serves any number of host computers, in a number of locations, from different vendors, managed by different elements of the university.

Technologies Not Favored

Depending on a variety of factors such as geography, user preferences, and the view taken of likely needs and technology directions, different approaches to implementing a network will be more or less applicable. As always, it is a question of tradeoffs. At Cornell, we have turned away from several directions:

1. **Vendor Nets** -- Networking facilities provided by the mainframe vendors tend to concentrate on interconnection of the

products of the particular vendor. Interface to IBM's SNA and Digital's DECNET from a general campus network may be useful at some point, but neither can serve as a general solution.

2. **Circuit Switches** — Units such as the Gandalph PACX, which provide transparent passing of data on asynchronous channels can be useful, but they are limited in capacity, impose constraints on geography, and have fairly high per-terminal or per-channel costs. If all computers can be assumed to be in the same location and if the ultimate capacity is not a concern, it comes down to economics. For each connected terminal, there must be a pair of drivers and a line to reach the switch, a port into the switch, a port out of the switch, a connection (presumably local) from the switch to the host, and a port on the host. Of course, multiplexors can be used to reach clusters of terminals, but a rise in complexity and a decrease in flexibility is apparent. (See Figure 2.)

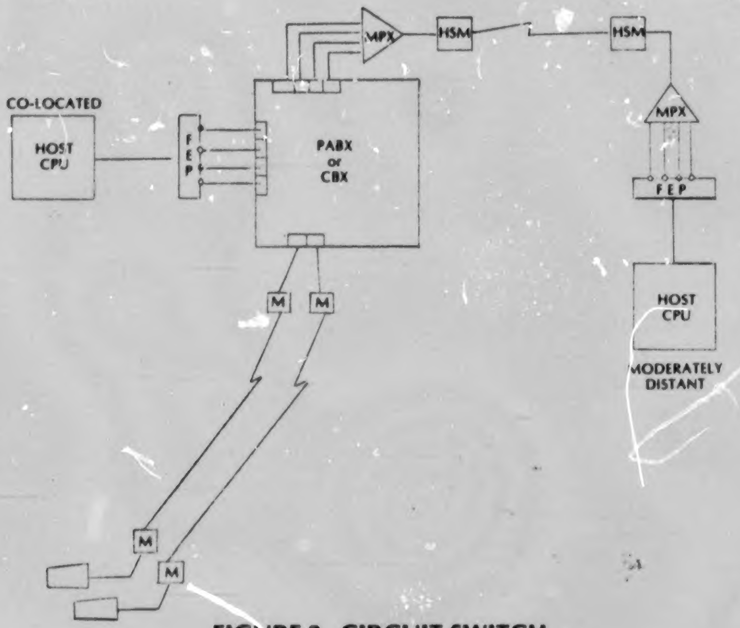

FIGURE 2. CIRCUIT SWITCH

3. Home Grown — While it's always tempting to think of designing and implementing one's own facilities, data communications is a complex field, and one in which the complexity is not even well bounded. At a minimum, it would be necessary to deal with system-level software, hardware, protocols, and interface standards. At Cornell, we never really considered this approach, though it has been seen as important to maintain a degree of control over and ability to adapt and interface to whatever facilities are acquired; which is to say that a turnkey system with facilities-management by a vendor would probably not be flexible enough.

4. Via Voice Telephone System — Referring again to Figure 2, the circuit switch shown could be one provided primarily for voice telephone communications but usable for data. Units available from Northern Telecom, Rohlm, and others are representative. The attractiveness of this approach derives from the observation that almost everywhere a telephone instrument exists, a terminal may be needed. If the expensive wire plant connecting the telephone instruments to the central switch could also serve for data communications, significant overall economies might be achieved. Ultimately, such an approach is probably the best answer. But although it may be realized in a few situations within two to four years, it won't in many for ten years or so. Capital costs projected for this type of installation for telephones range between $800 and $1200 per subscriber location. As with the computer circuit switch, two ports are tied up for each connection between computer and terminal. The costs quoted above include the share of the central switch for each subscriber, but in voice communications a very low ratio of holding time to elapsed time is commonplace. Accordingly, the switching facilities are designed to allocate a high bandwidth to each connected pathway for the duration of the connection. Data communications has the opposite characteristic; that is, terminals may remain logged on for hours at a time but with a very low average data rate. Consequently, the costs of maintaining connections must be minimized, and voice switches are not well adapted.

Candidate Technologies

Over the past decade, two primary technologies for data communications have been developed: packet data networks such as that pioneered by the ARPANET and cable networks using coaxial cables to serve local areas (e.g., Ethernet offered by Xerox). Other technologies such as satellite communications and cellular radio are either not well adapted to local networking or are not yet commercially mature and are not discussed here.

Packet Network For A Local Area — Figure 3 illustrates the essential components of a packet network implemented in a local environment. Packet nodes are mini-computers, or collections of microprocessors, or a combination. A number of them are interconnected by trunk lines; and terminals, host computers, and other networks are connected to whichever node is most convenient geographically. Over greater geographic distances, transmission speeds on network trunks may be restricted to 9.6 Kbps, but in a local network environment 56 Kbps should be the minimum. TYMNET and Telenet are public packet networks, and many EDUCOM schools will have had experience with them in the course of accessing EDUNET services.

Perceptible delays are sometimes experienced by terminal users due to the low trunk speeds and the frequent necessity for messages to transit several nodes and links in sequence. In a local environment, these delays should be negligible.

Packet nodes are capable of supporting as many as several hundred terminals, and they can be economical with as few as 20 or 30. With favorable geography, a single node may be used to support a cluster of adjacent buildings, connecting terminals via twisted pair cables. Within approximately 2,000-4,000 feet, current loop drivers supplied with most terminals can operate directly to current loop interfaces supplied as part of the packet node. This eliminates the cost of separate line drivers. If current loop drivers are not availalable for the packet node, then the requirement is at least reduced to a single driver.

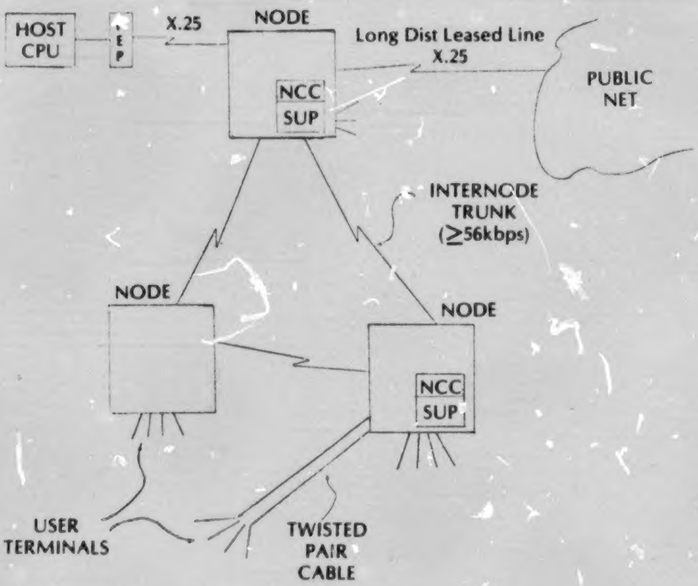
HOST
CPU
E
P
X.25
NODE
Long Dist Leased Line
X.25
PUBLIC
NET
NCC
SUP
INTERNODE
TRUNK
(≥56kbps)
NODE
NODE
NCC
SUP
USER
TERMINALS
TWISTED
PAIR
CABLE

FIGURE 3. PACKET NET

In a packet network, mechanisms must be provided to identify users establishing connections through the network, to permit users to request a particular host computer, and to deal with particular terminal characteristics. Also, network management facilities are needed for implementing changes to the configuration, monitoring and accounting for network utilization, and for diagnosing line outages or node failures. Each of the vendors of packet network equipment provides these facilities by its own mix of methods. Possibilities are: programs running in the packet nodes themselves, software on host computers connected to the network, or utilities on remote computers managed by the vendor.

Cable Networks — As shown in Figure 4, a cable network consists of a length of coaxial cable similar to that used in cable TV systems, with various devices attached by taps to the cable.

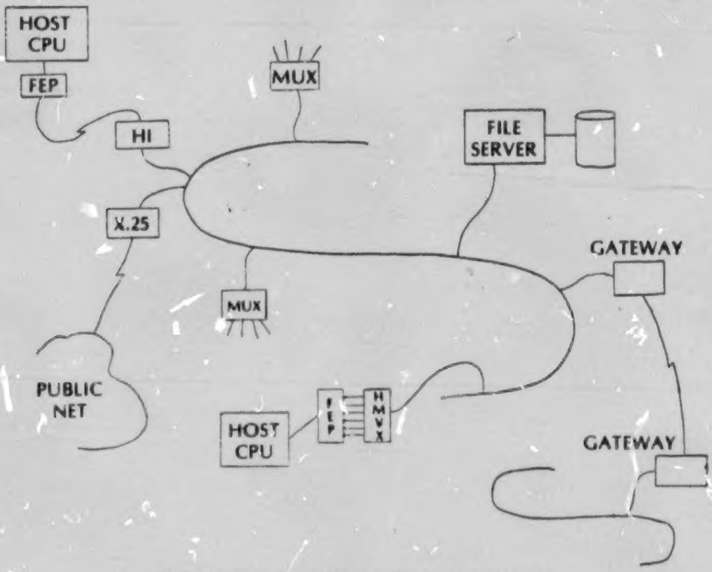

FIGURE 4. BASEBAND CABLE NET

The two basic approaches to use of coaxial cables are broadband and baseband. In a broadband environment, the capacity of the cable is divided into channels (as with cable TV) and each channel can serve a difference purpose. Voice, video, facsimile, and data can be mixed on the same broadband cable by assigning channels to each service. The most common approach to using channels assigned to data is similar to that used with a baseband coaxial system. The following discussion concentrates on the baseband cable system, but channels of a broadband system could substitute in many cases. Xerox's Ethernet, which has received the most public attention recently, is a baseband technology. For a good current summary of Broadband technologies, see reference 1; on a recent baseband announcement see reference 2.

Ethernet and other similar systems employ a broadcast packet contention system which is most easily understood by analogy to citizens band radio. As in CB, each station broadcasts a message which all other stations hear. However, only the intended recipient is expected to pay attention. When a message is correctly received, the recipient acknowledges receipt, and a transaction is complete. Of course, two stations may transmit simultaneously with the result that both messages are garbled. In this event, each waits a brief period and tries again. The system is not efficient in its use of available bandwidth, but the bandwidth is very great (10 Mbps) compared to the expected throughput and to its cost.

In contrast to the packet network, where network intelligence is concentrated in the computers which form the nodes, the necessary intelligent functions are distributed in a cable network. Microprocessor-based interfaces are used to attach terminals to the cable. Each such interface (shown as multiterminal multiplexers in the figure) can support one or several terminals. The microprocessor is responsible for forming packets from characters provided by the terminals, transmitting them onto the cable, receiving acknowledgements, and listening for and decoding messages destined for an attached terminal. Other devices such as interfaces to host computers and to public networks or to other cable networks also require processors to perform these common functions. In the Ethernet, a device called a file server can provide common storage for many users of the network.

An issue which is less clearly defined in the commercial market place for cable networks than for packet networks is that of network supervision and control. Collection of statistics on network use, installation of configuration changes, and the like can be assisted by software residing in any of several devices attached to the cable. Other areas where assistance in network management and user access may be needed such as the maintenance of user directories readily come to mind. Announcements from vendors should clarify some of the possibilities soon. (Also see reference 2.)

Comparison of Cable and Packet Technology

In some sense, a baseband cable loop and a mini-computer based packet node are architecturally very similar. As shown in Figure 5, both employ a high speed bus, which is the backplane in the mini-computer and the cable itself in the cable network. Devices attach to this bus, and an interface for terminals is represented in both cases. The complexity of functions to be performed by this interface will be somewhat higher in the case of the cable network, since no central processor exists to assist in terminal handling. On the other hand, these functions can be expensive to perform on a CPU, and the trend in design of packet nodes is to include microprocessors on line-interface circuit cards. If a cable needs a central source of intelligence, a mini-computer such as the Ethernet file server can be attached.

To compare the technologies, baseband network segments and packet nodes are used in Figure 6 to construct equivalent local networks, each serving three clusters of three adjacent buildings. Since the intelligence is more distributed in a cable network, the diagram appears somewhat more cluttered. In practice, the cable-net might be as easy as or even easier than the packet-net to implement.

Costs of network components are shown in Table 1. These costs derive from experience at Cornell (packet nodes, cabling, host interfaces) and from a report prepared for the Executive Office of the President[3] and from discussions with various vendors. In most cases, the costs shown represent currently available commercial technology. However, some elements shown for the cable network are not expected to be widely available for one or two years.

Table 2 provides a rough budget for capital costs projected to implement a network of 400 terminals in 9 locations, serving two host computers, and interfacing to two public networks. Given the estimating uncertainties and the likely variation in applicability of features in different environments, the costs of the two approaches as shown should be considered equivalent.

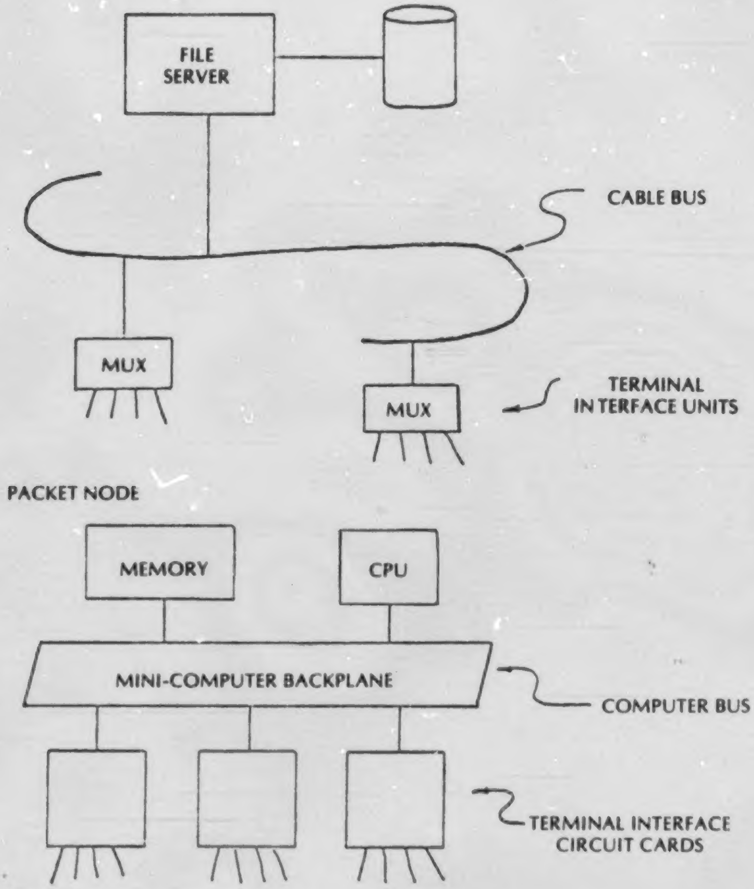
FILE SERVER
CABLE BUS
MUX
MUX
TERMINAL INTERFACE UNITS
PACKET NODE
MEMORY
CPU
MINI-COMPUTER BACKPLANE
COMPUTER BUS
TERMINAL INTERFACE CIRCUIT CARDS

FIGURE 5. ARCHITECTURAL COMMONALITIES

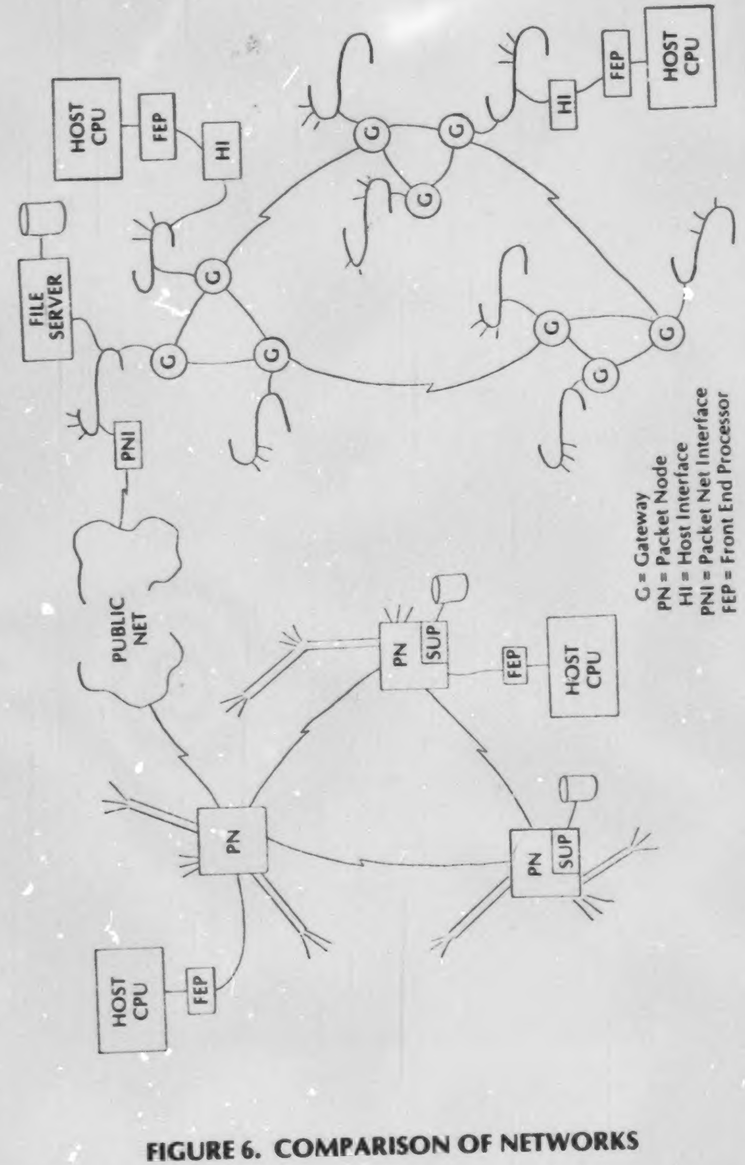
HOST CPU
FEP
HI
FILE SERVER
HOST CPU
FEP
HI
PNI
G
G
G
G
G
G
G
G
G
PUBLIC NET
PN
PN
SUP
PN
SUP
HOST CPU
FEP
HOST CPU
FEP
G = Gateway
PN = Packet Node
HI = Host Interface
PNI = Packet Net Interface
FEP = Front End Processor

FIGURE 6. COMPARISON OF NETWORKS

PACKET NETWORK

	LOW	HIGH
Node	25,000	150,000
SUP/NCC	100,000	200,000
MPX Host Interf. & Share of FEP	10,000	30,000
Inter-node Link	5,000	20,000
Cable to Adj. Bldg.	12,000	18,000
Wire Building	6,000	10,000
Term. Interface on Node/Term.	100	600
Wire to Terminal	75	125
Interf. to Ext. Net	5,000	10,000

CABLE NETWORK

		LOW	HIGH
N/A			
"File Server"		150,000	300,000
MPX Host Interface (w/Share of FEP)		25,000	40,000
Connect Loops	Gateway	8,000	20,000
	Cable	5,000	15,000
Cable Building		4,000	8,000
Tap/Pr. Term.		600	1,200
Wire to Terminal		75	125
Interface to Ext. Net		8,000	25,000

TABLE 1
CAPITAL COSTS FOR NETWORK COMPONENTS

9 BUILDINGS — 400 TERMINALS — 2 HOSTS — 2 PUB NETS

PACKET NETS

		000's	
		LOW	**HIGH**
(3)	Nodes	250	400
(1)	NCC	—	200
(2)	Host Interf.	20	50
(3)	Inter-node Links	60	75
(6)	Cable to Adj. Bldg.	72	108
(9)	Wire Bldg.	54	90
(400)	Term. Interf.	50	240
(400)	Wire Terminal	30	50
(2)	Interf. to Ext. Net	10	20
		546	1233

CABLE NET

		000's	
		LOW	**HIGH**
	"File Server"	150	300
* (2)	Host Interface	50	80
(9)	Gateway Processors	72	150
(12)	Inter-loop Cables	60	150
(9)	Wire Bldg.	36	72
(400)	Terminal Taps	240	480
(400)	Wire Terminal	30	40
* (2)	Interf. to Ext. Net	16	50
		654	1976

* Not readily available commercially

TABLE 2
CAPITAL COSTS FOR 400 — TERMINAL NETS

In both cases, a growth in the number of terminals or host computers would not be matched by a corresponding growth in overall costs. Operating costs have not been budgeted but could be expected to fall between 10% and 25% of the capital costs annually. The amortization of capital costs would be added to this amount.

Summary Comparison: Cable and Packet

The cable network because of its high speeds and distributed architecture promises very wide applicability. So far, however, this technology is not mature in the market place. No single vendor offers a complete range of facilities and interfaces; good pricing data is hard to find. Within 2-3 years or sooner, all the required building blocks should be available off the shelf, and two or three vendors should have complete offerings.

In packet networks, at least half a dozen vendors have products in the field now. The interfaces between packet networks and many kinds of terminals are highly refined. Also, a variety of means exists for attachment of host computers. Packet nets operate at medium speeds of 50-100 Kbps per second at best, usually below 9.6 Kbps for terminals although this limit will rise.

At the present time, to realize the objectives of local networking, a *manageable growth in terminal population with continuing access to a variety of on and off campus computing resources*, the following constraints might apply. If the campus is compact, a circuit switch could do the job. If the human resources are available for an experimental project, a cable-net could be implemented. If an immediate vendor supported solution is required, local packet-nets are available. In the next few years cable-nets will become increasingly important for local communications. At Cornell, we now employ some packet technology, but as we install twisted pairs, we're running coax and optical fibre as a hedge against the future.

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LIBRARY

28

The Impact of Automation on University Libraries: An Investigation

Hugh F. Cline and Loraine T. Sinnott
Educational Testing Service

I. Introduction and Background

In recent years, university libraries have increased the use of computer-aided systems to accomplish their major functions of acquisition, cataloging, circulation, and reference service. It is certain that this commitment to automation will continue to expand. This paper reports on a research study that identified and analyzed changes in the organizational structure and function of university libraries resulting from automation.[1]

Organization charts for most university libraries indicate two major library substructures. The first, public services, usually includes reference departments, circulation departments, and various special collections or branch libraries. The second, technical services, usually includes acquisitions and cataloging departments. To the library user, technical service operations are rarely visible, for they comprise the technical and clerical activities of ordering materials, monitoring delivery, cataloging materials, and preparing them for circulation. Public services, on the other hand, are highly visible operations, for they help library users find items in the collection. Public service staff provide guidance in using aids such as the card catalog, which the technical services staff have created to assist in identifying and locating materials. Public service librarians are usually responsible for selecting new materials and setting collection development policies.

Our research focused primarily on the operations of technical services, for most of the automation in university libraries has thus far been centered there. Providing automated support for the work of public service departments, such as reference or collection development, is only now beginning to receive attention in university libraries.

From a sociological perspective, automation within university libraries is a particularly interesting phenomenon because it has led to significant changes in the practice of librarianship and has fundamentally modified the role of at least one central library figure, the cataloger. It has also radically altered a library's relationship to its environment. Although the expense of cataloging new acquisitions had motivated libraries to start sharing catalog data long before computers were invented, computers greatly facilitated the sharing of bibliographic information. In many instances, these records can be remotely accessed by libraries via telecommunications systems. These systems have encouraged the proliferation of library networks, a development that is changing the organizational boundaries of libraries.

Historically, the university library has been a relatively stable and autonomous organization, maintaining a low profile within the academic community of its host institution. However, the movement to networking has become a major influence in altering the traditional isolation of the university library. Networking is forcing individual libraries to become more visible, as collegial members of a larger community of libraries. It is also forcing them to compromise their autonomy in order to take advantage of the resources offered by cooperative arrangements. The research project thus undertook to examine in detail the kinds of changes occurring among university libraries as they increase their use of computer-aided systems.

The project was designed to produce a dual payoff: first, a contribution to the sociological literature focusing on technological change in complex organizations and second, the development of policy implications of the research, so that the issues of future management and support of university libraries can be addressed.

II. Methods

Because of the complexity of the phenomenon, the investigation employed a comparative case study design.[2] Four university libraries participated: The University of Chicago, Northwestern University, Stanford University, and the University of Washington. Data collection methods included personal interviews, field observation of library activities, and collection of existing library reports and documents.

The data collection procedures were designed to be exploratory, generating hypotheses for testing in future research. The case studies were structured to uncover in some detail the variety of organizational changes that accompany the introduction of a new technology to enhance goal achievement. Multiple case studies were completed to provide a rich comparative data base from which to speculate on generalizations pertinent to other university libraries. Within each university library the data collection procedures were replicated. In addition to increasing reliability of the data, the replication permitted comparisons among the four sites.

Data collection site visits averaged two weeks in each library. Most of the fieldwork time was devoted to interviewing. A total of 216 librarians and university administrators were interviewed, and each interview lasted approximately one hour.

All data were integrated into comprehensive accounts of automation that focused on how each library accomplished acquisitions, cataloging, circulation, and reference services. The data were then reviewed and organized to address several theoretical and policy-relevant concerns.

Further structure was provided for both data collection and analysis by a sociological perspective that views complex organizations as having the following characteristics:

1. A structural dimension; the organization is seen as a series of task assignments ordered by a division of labor and connected via authority and accountability relationships.
2. A fiscal dimension; the organization is seen as an agglomeration of monetary resources connected via budgetary and accounting relationships.
3. An information dimension; the organization is seen as a network of decision-makers connected via data channels.
4. A personnel dimension; the organization is viewed as groups of persons connected via behavior patterns.[3]

It is obvious that these four dimensions are not exhaustive of all aspects of complex organizations. It is also true that they are highly interdependent and, therefore, not mutually exclusive. However, these dimensions provided an appropriate framework within which to analyze the voluminous data collected during the course of four comparative case studies.

III. **Findings**

The four institutions participating in this project provide a diverse array of manual, semi-automated, and automated systems for accomplishing the functions of acquisition, cataloging, circulation, and reference service. The chart below presents an oversimplified description of systems used in each library.

	Acquisitions	Cataloging	Circulation	Reference
Chicago	LDMS	LDMS	LDMS	LDMS Commercial
Northwestern	NOTIS	NOTIS	NOTIS	NOTIS Commercial
Stanford	RLIN	RLIN	Manual	RLIN Commercial
Washington	Manual	WLN OCLC	Manual	WLN Commercial

The University of Chicago's Library Data Management System (LDMS) is used to aid in accomplishing all of the above functions. LDMS was developed over the past decade with substantial support from outside public and private funding agencies. No financial support has been available for enhancing LDMS for the past year, and the system is now in transition from a developmental to an operational phase. Hence, it was possible at Chicago to document the use of automated systems in a relatively mature and stable technological setting. The Northwestern On-line Total Integrated System (NOTIS) is also an integrated system but was developed solely with local resources. Since NOTIS started in the mid-1960s, Northwestern also provided a relatively mature technological site for observation. However, additional enhancements such as an on-line authority file are underway, and the Northwestern environment is more dynamic than Chicago's.

Stanford University and the University of Washington have significantly automated one or more library functions. Stanford, which is now the flagship library for the Research Libraries Information Network (RLIN), has automated acquisitions and cataloging of monographs. Serials control is not yet included and circulation uses a manual system. All design and development work that will affect the Stanford University Libraries are accomplished by the RLIN staff with collaboration and assistnace from the Stanford Computation and Information Center. The RLIN data base is undergoing rapid expansion as more academic libraries join the Research Libraries Group. The University of Washington has recently become a member of the Washington Library Network (WLN). However, it more frequently employs the Ohio College Library Center (OCLC) data base for cataloging activities. Acquisition and circulation at Washington are accomplished through the use of manual systems.

It must be stressed that the chart and summary statements presented above are gross oversimplifications of an exceedingly complex and diversified pattern of task accomplishment in these four libraries and thus cannot be taken as a complete or definitive report. For example, although the chart indicates that both Chicago and Northwestern use their integrated systems in accomplishing acquisitions and cataloging, NOTIS includes serials control, and LDMS does not. Another example is that although the Washington acquisitions system is primarily a manual operation, both the OCLC and WLN data bases are used for preorder searching. Perhaps the greatest oversimplification occurs in the reference column, where all institutions are depicted as having access to both commercial bibliographic search services as well as local or regional holdings information. In fact, the institutions vary significantly in the amount and sophistication of automated reference services provided. For example, Stanford uses the same hardware for searching the RLIN bibliographic file and the commercial data bases, but the University of Washington rarely uses either the OCLC or WLN data bases for reference services.

Presentation of the remaining findings is organized by the four organizational dimensions introduced above. First, with respect to the structural dimension, the data were examined to determine the impact of automation on acquisition, cataloging, circulation, and reference. In acquisitions, most university librarians clearly recognize that machine-readable item-identification tools have a tremendous potential for more effective management of collection development activities. However, this potential is as yet largely unrealized because bibliographers and item selectors rarely have easy access to terminals for searching data bases and ordering new materials. In addition, frequent breakdowns of the automated system tend to immobilize automated acquisitions departments. Because almost all activities in such departments are dependent on access to on-line order files, an outage produces a substantial loss of productive work.

In many cases, automated acquisitions systems produce a reorganization of work flow and functional units within the library. Formerly independent search and order units may be combined into a single unit. Claims units are eliminated, since automated systems handle these procedures routinely. Gifts and exchange units are usually more effectively integrated into technical services.

In cataloging, computer-aided systems are dramatically reducing backlogs in many university libraries. However, automated cataloging is creating a new problem, a backlog of the unfiled catalog cards that are produced at a much higher rate by the new system. Hence, the costs of catalog maintenance are escalating. Furthermore, the number of original catalogers in most automated university libraries is decreasing, their tasks being accomplished by nonprofessional library staff members known as copy catalogers. Many original catalogers report perceptions of decreased status within the library as a result of automation, the establishment of copy catalog units, and the accomplishment by non-professional staff of tasks for which they previously had sole responsibility.

Before the installation of automated circulation systems, many university libraries anticipated significant reductions in personnel and operating costs. Yet in two libraries included in this study, cost savings have not yet materialized. Rather, their circulation activities have expanded. Such tasks as recalling items, issuing overdue notices, collecting fines, issuing lending privileges, reshelving items, maintaining stacks, completing collection inventories, and identifying materials in need of repair or binding have traditionally been assigned to circulation departments. Because of limited resources, these tasks were rarely fully accomplished prior to automation. Now, however, they are all more thoroughly and efficiently completed because staff are relieved of the primary tasks of charging and discharging items.

With respect to reference activities, many librarians report ambivalence about expanding the use of commercial search services. Librarians are troubled by having to pass on direct charges for these services to the users. Moreover, there is concern that normal reference suffers because automated services are so time consuming. Many university librarians also report that using commercial search services vastly enlarges the demand for materials, a growing proportion of which are not among the library's current holdings. Hence, in some institutions requests for material through interlibrary loan are proliferating as a direct result of the comprehensiveness of the data bases employed by the commercial search services.

Automated support for materials processing in university libraries is far less developed than for monographs. Northwestern University is the only major university library that provides detailed holdings information on the on-line bibliographic data base. Many university librarians report that future automated serials services will provide bibliographic access to the contents of serials; i.e., at the level of individual articles. It is expected that this capacity will further modify the delivery of reference services and the patterns of serials use.

Within the fiscal dimension, one can distinguish among five sources of funds, internal to the university, that can be used to introduce and maintain automated systems: budget increases, budget transfers, loans on future-year budgets, user fees, and sales of rare and valuable items in the library's collection. There are also two external sources, grants and contracts; the latter can be further subdivided into contracts with commercial firms and contracts with state agencies. When iternal funding sources are used, faculty members have negative reactions to automated activities if they perceive that these funds have been diverted from collection development.

The methods of cost-benefit analysis of automated activities are not uniformly applied in university libraries. Very few libraries are able to make reasonable estimates of costs involved in developing systems and training both library staff and users to employ requisite new procedures. There are very few precedents for measuring either costs or services delivered by the university library; managers will need to give increased attention to improving their capacities for estimating both costs and benefits of automated systems.

With respect to the information dimension, the study revealed that the sharing of a centralized bibliographic data file in automated technical service units fosters closer communications among staff. In some instances, a temporary dual hierarchy is created when systems department staff are involved in designing and implementing automated systems. Both systems personnel and regular supervisors may exercise control over job performance. Many university librarians also report a growing perception of the need for a liaison between automated systems and public service librarians.

During the interviews, data were collected on work-related communications patterns. On the basis of these data, we found that changes in communication patterns frequently accompany the introduction of automated systems. Furthermore, the instability in interaction appears to become continuous and even permanent. In recent years, university libraries have organized various committees, task forces, and working groups to study specific problems or projects, thus further changing communication patterns. It appears that libraries may gradually be adopting a matrix organizational structure in which individuals have one major functional assignment to a library department or unit and, simultaneously, one or more temporary, substantive committee assignments to work on specific projects or problems. This type of matrix organization may become more prevalent in university libraries, for many administrators report that it is especially effective in addressing technology-related issues.

When we reviewed the personnel dimension of university libraries, it became clear that participatory management, in which informed staff seek consensus on policy issues, is widely used. However, when policy issues concern technical matters and when expertise in such matters is not uniformly shared, a dilemma emerges from the conflict between experts and managers. Hence, library managers are likely to be faced with a problem, the resolution of which will require creative leadership.

The comparative case studies also revealed that automation has caused many changes in traditional personnel management areas, including hiring, job assignment, evaluation, and the like.

The requirements for new skills, expertise, and training are changing personnel policies in university libraries. This situation raises the important question of appropriate training in information science for professional librarians. On the basis of interviews with over 200 librarians, we concluded that dissatisfaction with graduate training programs is widespread and uniform among practicing university librarians. This disgruntlement clearly implies that library managers, as well as library school faculty, should thoroughly review the objectives, content, and success of their preprofessional and continuing education programs.

Footnotes

[1] This project was supported by the Library Research and Demonstration Program, U.S. Department of Education, and Educational Testing Service. The final report is being prepared for publication in 1981.

[2] A more detailed description of the methodology of comparative case studies applied to academic libraries is contained in a report of an earlier study conducted by the authors on collection development. See Hugh F. Cline and Loraine T. Sinnott, *Building Library Collections: Policies and Practices in Academic Libraries*, Lexington, Mass.: Lexington Books, D.C. Heath, 1980).

[3] This perspective is adapted from the work of G.C. Nielen, "Foundation for a Curriculum 'Large Systems'," in *Education and Large Information Systems*, ed. R.A. Buckingham (Amsterdam: North Holland Publishing, 1977), pp. 169-173.

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Impact of Technology on Organization and Staff In College Libraries

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The body of literature treating the effect of technology on organizational structure and personnel is enormous. It includes newspapers such as the Wall Street Journal, professional trade journals and newsletters, and of course the scholarly literature in any area of the social sciences concerned with the behavior or relationships of individuals within an organization. Studies of library personnel have been a part of this literature and focus on such isues as how the new technology affects morale or working relationships and what it means for the retraining of personnel — problems similar to those in other fields. Most conclusions reached in the library literature are not particularly surprising; some are not particularly edifying. A typical conclusion is the one reached in a 1977 study, which read, "Organizational change mandated by automation . . . must be viewed as both an institutional and professional opportunity that can be rewarding and challenging." That's not a particularly earth shattering statement, though in fairness, it is difficult to reach easy conclusions. This paper does not seek conclusions, but attempts to lay out some of the issues that college libraries face in dealing with technology.

College libraries are different from university libraries. That is basic, and must be recognized. Their resources are limited and less specialized. The nature of their mission — to support undergraduate teaching rather than graduate research — is also an important difference. But for the purpose of this discussion, the most significant difference is the size of the professional staff. To cite just one state as an example, of the 41 accredited four-year (or more) institutions in Indiana — by no means a poor state — 29 have five or fewer professionals, and of those twelve have only one or two. Larger libraries are concerned with how technological changes will affect the traditional organizational structure, a structure that is based on function, activity, subject matter, format of material, type of clientele, location, or some combination of these. When the issue we're discussing is raised, the kinds of questions asked of university librarians are: Should there will be a restructuring of staff or of duties? Where do the systems analysts fit in a line organization? But in college libraries, even the relatively affluent ones with five or six professionals, there is not this clear difference of function, and very little structure. Everyone does some reference work, suggests materials for ordering, and participates to some extent in setting policy. And because the differentiation of function is so minimal, everyone has to be a generalist.

What this means, of course, is that probably no one on the staff has the expertise to have really good judgement on the new technology. The typical college library staff has difficulty judging even what factors determine what should be considered; let alone how or when the library should become involved or even what the choices are in automation or on-line searching. It is also unlikely that such libraries are going to be able to add younger staff members who have much knowledge in such areas. Staff turnover is generally infrequent, and relatively low salaries and limited resources prompt those who have a real interest in and knowledge of technology to take positions in libraries where the salaries are better and the possibility of working with the new technology more likely.

At the same time, the library budgets of these institutions are barely enough to support a few hundred subscriptions, much less such basic and expensive tools as *Biological* or *Chemical Abstracts.* If they can't handle those, how can the expense for on-line equipment and connect time be justified? And it's even more difficult to persuade faculty and administrators — because they're neither familiar with nor interested in the capabilities — that on-line technology is important and their library staffs need to be able to understand new technology even if it means release time and travel funds.

So on the one hand, we have libraries that lack resources and facilities, librarians who lack expertise, and in too many cases, administrators unwilling to provide the support to ameliorate these lacks. In addition, many teaching faculty associate technology with research and so consider it irrelevant to their needs.

On the other hand there are factors and reasons that will encourage change. First, new, younger faculty, accustomed to on-line services in graduate schools or previous positions will create a demand for them, and many older faculty will want to use them also. The role of the librarians will be important here. As F.W. Lancaster and his colleagues point out in their intriguing article, "The Changing Face of the Library: A Look at Libraries and Librarians in the Year 2000," ". . . more and more scientists, social scientists and other professionals were using on-line systems directly. At least they were conducting their own searches in those data bases they had most need for and had become most familiar with. They still tended, as they do today, to go to the information specialists for searches in less familiar areas or less familiar data bases." Although the type of materials used will be different, the role of the reference librarian for the faculty is now and will continue to be helping the specialist outside his or her specialty. A second factor is that the growing competition for students (because the number of 18-year-olds will continue to decrease until the middle of the '90s) will force colleges to offer facilities comparable to those of their competitors. Thirdly, the cost of equipment and on-line services will decrease, probably absolutely, but certainly relatively, compared with the costs of labor and printed materials, and resistance to buying them will diminish.

These factors press for change, but there are also educational reasons why, even if those factors weren't present, change is desirable. First, change will help to revive faculty members for whom creativity has become barren, and whose teaching has become dreary. Every college and university has some faculty like this, but this is a special problem at smaller colleges because the quality of teaching is so crucial. Although it is obviously not a magic solution, learning new ways of doing research — by using data bases for example — may help. Even more important, though, is the responsibility the college has to train students who will be at the peak of their careers in the next 20 years. They must be trained in new ways of gathering information which will help them as professionals, business people, or just active, concerned citizens.

We have, then, on the one hand, limited resources, inadequate personnel, and resistance to change, and on the other, changing circumstances and responsibilities that demand a new approach. How will these be reconciled?

Librarians have been changing. There's a recognition that "the times — they are a-changin' " and that it is one's responsibility as a professional to become familiar with the new technology. Consequently, more and more librarians are involved with continuing and self-education. Technology itself is helping college librarians to do this because it frees them from more or less routine jobs, and allows more time to read about and explore new technologies. After traditionally-trained librarians (and clericals) overcome that initial fear of technology, the next encounter is much less threatening. One fortunate paradox of computer technology is that an increase in complexity of performance is not necessarily accompanied by an increase in complexity of operation. Library staffs must take advantage of every opportunity to find out about the new technology. This means keeping up with the literature, of course, but even more importantly it means talking with others, visiting installations, and listening to experts at meetings and workshops.

College librarians and administrators need to reorder their priorities to provide development opportunities for their staffs. Even before this they must begin to see the importance of the new technology. This is difficult because most administrators are conservative and not known for receptivity to librarians' entreaties — especially not their own librarians! The most telling influence on these administrators will be, one, their own faculties, and, two, what other colleges are doing. As faculty demand increases and more and more colleges adopt new technology, it will then become easier to convince the administration that it's important for their libraries to do so as well. But it will still be necessary for library staffs to obtain travel funds and release time.

State, local or regional networks provide the best way of meeting this educational need. They understand the local situations and can relate to individual libraries on terms that are appropriate. They have the expertise to provide advice and information, and can produce training sessions and instructional materials, workshops, conferences, manuals, etc. And, of course, they are nearer, so that travel expenses are minimized. INCOLSA (Indiana Cooperative Library Services Authority, which serves all types and sizes of Indiana libraries), for example, has been invaluable for Indiana college libraries. Without it many of us would still be operating as we did twenty years ago.

If these obstacles and corrective factors can be reconciled — and it appears to be happening — the implications for college libraries are profound. While they still have small staffs and small in-house collections, the resources technology makes available to them will be enormous. They will have, for all practical purposes, the bibliographic resources now available to the largest libraries. That will help alleviate some of the problems mentioned above; it will be easier, for example, for a college library to attract more knowledgeable staff members. On the other hand, it will create some new problems, problems resulting from an abundance of informational resources. Problems? No, opportunities. it means first-rate support can be offered in supplying information to faculty and students. The job then will be to teach faculty and students how to make the best use of that information, how to be efficient in finding it, and how to be discriminating in using it. That's a job that will be a pleasure since it will enable librarians to become true partners in the educational process.

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Impact of Technology on Organization and Staff In Libraries

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Following over two decades of work, and slightly more than one decade of work concentrated on the development and implementation of on-line services, library automation is accepted by librarians and their institutional administrations, as a necessary component of library operation. This acceptance is largely due to the compelling technical, fiscal, and social logic underlying OCLC and the smaller bibliographic utilities. The combination of strong central development coupled with sensitive local implementation through regional networks, and the concomitant symbiosis between region and center manifest in governance and advisory structures, has effected a technical and social revolution within libraries of all types.

Libraries now perceive the operational and fiscal advantages to be gained from on-line library network participation and administrators are now prepared to redirect funds to achieve participation, rather than relying on grants and other artificial support mechanisms. Equally important, library professional and support staffs have accepted both retraining in new techniques and the advisory and participating responsibilities called for by governance procedures. The library network has become a social organism which crosses many established boundaries.

The effects of library automation have to date, however, been limited to sporadic essays in improved cost efficiency. It is now possible to review series of data, albeit by fairly primitive mechanisms, and note the effects of the introduction of library automation on academic libraries. Within SUNY, careful review of manual statistics over a number of years indicate reassignment of staff from technical to public service and improvement of materials processing performance.

Examples of the effects of participation in OCLC, based on a statistical survey of the 32 state-operated campuses of State University of New York (i.e. including the Community Colleges), are:

- improved processing efficiency of library materials with elimination of uncataloged backlogs, faster throughput time, etc.
- reduction of technical processing staff.
- reallocation of staff from technical to public services (with a 16% increase of public service staff hours in three years).
- increased interlibrary loan traffic with the University receiving 16% more requests and maintaining the same satisfaction level (73%).
- improvement of internal inventory control and improved access to the database via on-line terminals (as opposed to traditional card catalog) which results in the library finding more of its own material and hence making less requests outside.
- wider range of library and curricular materials brought into coherent bibliographic control.

In short, and gratifyingly, many of the claims made by early proponents of on-line networking are demonstrably true.

Much more work needs to be done in order to use library automation to create a coherent library management structure, in which a library achieves improved cost effectiveness not only in its expression of its own institutional mission, but in its relationship to its fellow cooperating libraries.

The next real question is whether or not it is possible to establish a bibliocentric view of the University rather than a pedagogic view? This paper proposes that it is.

Research undertaken in SUNY Central Administration has resulted in the definition of an automated library management information system which currently links the library acquisition and retention decisions with book publishing output and academic mission (expressed by such disciplinary effort data as student credit hours, FTE or headcount enrollment, faculty FTE, instructional costs, etc.), and will soon incorporate feedback from library circulation and interlibrary loan systems. Preliminary studies have shown a strong correlation between academic mission and library collection development, while at the same time library collections in a set of institutions demonstrate high uniqueness.

The first stage of development of the management-information system is the linking of library collections (as captured from OCLC distribution tapes) to the disciplinary student credit hour enrollment data from the SUNY Course and Section Analysis files. This is done via tables which express Higher Education General Information Survey (HEGIS) Taxonomy as sets of library of Congress Classification Numbers. This stage is now complete.

Preliminary studies of these data demonstrate that, unexpectedly, there is considerable coherence among the colleges and the University in the allocation of library acquisition funds at the macro decision level, i.e., general support allocation for a discipline or program. For example, approximately the same relative percentages of investment effort between student credit hours and titles acquired are found on each campus. Conversely, at the micro decision level, i.e., the decision to acquire or retain a specific title, there is wide dispersal of effort. The same books are *not* bought by each campus. For example, of 105,000 OCLC records for monographs with 1977 or 1978 imprints cataloged by 10 colleges between 1977 and 1979, 45,000 represented specific titles (the balance of 60,000 are multiple copies). Only 171 titles, or less than 0.3%, were collected at all ten campus libraries, while 25,475 or 53.88% were unique titles found only once in the set of 10 libraries.

Results such as these are only attainable through analysis of data derived as a by-product of a library's adoption of automation; and specifically of network automation. They have a welcome import, but they do raise very serious possibilities which must be addressed by academic administrators.

It is apparent that a group of libraries together have great richness and diversity of resources. These resources are now assessable by institutional management, and accessible by users from other libraries, via on-line interlibrary loan systems, with fine efficiency, and at reduced total costs. Questions remain. What are the implications of these data for library services, library staffings, and library collection policies? What is the role of large research libraries whose collections are not dissimilar to the sum of the collection of small libraries in such a network? What are the implications for academic program development and integration? What are the appropriate investment patterns to capitalize on the current and newly realized assets?

I submit that academic administrators will be working with these issues in the near future. We have by no means seen the end of the impact of technology on academic libraries. The predictable, and predicted, outcomes have occurred and continue to occur. The new data presents a new set of conditions to be assimilated. Fortunately the date are optimistic and can only lead to improvement in cost effectiveness of academic library service.

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The Integrated Library System Design Aspects for Collection Management & Control

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I. Introduction

This paper resulted from an invitation to address the topic "Automating Circulation Systems & Inventory Management" at a session by this title at the Annual EDUCOM Meeting, October 1980, and is based on three years experience in the design and development of an Integrated Library System (ILS).[1,2] Before proceeding, it is necessary to clarify the distinction between the terms "circulation control" and "inventory management" suggested by the session title, and the preferred terms "collection control" and "collection management" used in this paper.

Collection Control vs. Circulation Control

Circulation control is, in general, concerned with the location and status of items which are either circulating or to be circulated outside of a library. If, however, as Michael Buckland states:

> "The essentially logistical problem of making library books [monographs and serials] physically available when wanted by library users is central to librarianship."[3]

then the concept of circulation control must be extended to complete item[4] control within and without the library. Collection control, as used herein, is defined as follows:

> *collection control:* The location and status of each item at all times (not just during circulation).

Collection Management vs. Inventory Management

Inventory management in non-library situations is usually concerned with inventories of depletable items and addresses questions concerned with (1) location, (2) quantity on hand, (3) when to re-order and (4) status of the order. While the items of concern to library management are not, in general, depletable, the task of making library books physically available goes beyond collection control; it includes decisions on what items to acquire, what items to weed, loan policies, location (and relocation) of items, etc. This is the area of *collection management.* As a library discipline, collection management is best described in Michael Buckland's treatise, "Book Availability and the Library User"[5] and in the editorial policy of "Collection Management: A quarterly Journal Devoted to the Management of Library Collections."[6] For purposes of this discussion, it will be defined as follows:

> *collection management:* Management of library activities relating to the collection of such as selection and acquisition, weeding, binding, shelving, etc.

It is important to note that since the depletability or non-depletability of items is a basic distinction between inventory management and collection management (and control) as defined here, the latter may apply to the control of any non-depleting collection be it books, audio-visuals, or museum artifacts.

The primary emphasis in this paper will be on collection control and collection management support. Section II and III will briefly address aspects of these activities that impinge on, or are important to, the design of automated systems. Section IV will highlight features of ILS Version 1.0 that respond to requirements identified in Section II and III. Section V will address similar planned features of ILS.

II. Collection Control

The key to determining item availability is an accurate, current and easily accessible record of the location and status of the item. The impediments to simultaneously maintaining accuracy, currency, and easy accessibility of records in a manual system are so many, and the implicit processes so labor intensive, that collection control is unlikely to be achieved without automation. Some factors have, for the same reasons, not even been considered in manual systems (e.g., "temporary" location described below). Central to any collection control system will be a record containing location and status information on every item in the collection. Locations to be tracted should include:

1. **Patron:** The maintenance of this information is the traditional function of a circulation system.
2. **Shelf:** Accurate and alterable shelf location is particularly important because of the need to relocate items dynamically based on management priorities such as reserve status, new acquisitions, topical subject matter, etc.[7]
3. **Temporary:** Identifying the temporary location of items on carts awaiting reshelving and/or items in technical processing (e.g., cataloging, indexing, etc.) is most often neglected. The ability to track items accurately, without encountering the ambiguous "not-on-the-shelf" situation, should be an important priority of every library.
4. **Department or Branch**
5. **Interlibrary Loan:** In interlibrary loans, the borrowing library is essentially a Patron of the lending library. The borrowing library must, in turn, use its locator system to track the item (e.g., to a patron, reserve shelf, etc.).
6. **Bindery**

7. **On-Order:** Even items on-order should be considered part of the current collection. In this case the location is implicit and the status is of major concern.
8. **Other:** Other locations include study carrels, learning carrels, reading room and photocopy stations.

III. Collection Management Support

Decision support for collection management requires the collection of appropriate data, and the generation of appropriate reports. What are some of the needs?

Acquisition policies in libraries are usually based on some measure of subject relatedness and are further refined through actual usage.[8] Usage data, as normally acquired, however, may be a biased measure: "Certainly the [circulation] data will lack details of items used inside the library, usage of copies personally owned or borrowed from other libraries or attempts to use items not found in the library. However, attempts to make explicit adjustment for thise factors [manually] rapidly become unmanageable. . . ."[9]

A major controversy regarding acquisitions policies at large academic research libraries (Pittsburgh Study[10]) remains unresolved due to the lack of in-house usage data. A study of book acquisitions and circulation at the University of Pittsburgh has resulted in a heated controversy regarding acquisition policies in academic research libraries.[11] The study underscored the low percentage of acquired books that were circulated and suggested that such data be used to reduce acquisitions and, hence, library expenditures. Critics of the study emphasized the high rate of in-house usage of books by research scholars as compared to books circulated to students. Since the explicit policy of research libraries is to support research scholars, not just students, a major aspect of the controversy remains unresolved due to the lack of in-house usage data.

Weeding policies could also be more effectively guided by usage rates if accurate "in library use" data could be obtained.

Many libraries in the biomedical library community do not circulate journals. In these cases there exist no usage (circulation) statistics in the usual sense to guide either journal acquisition (multiple copies) or weeding.

Shelving policies may not only be guided by usage rates but may also impact them.[7] The special location of new books, books of topical interest (e.g., Bicentennial books, Christmas literature, etc.), and reserve collections (e.g., course references) will certainly influence their usage rate. For reference or reserve items, data on usage within the library is, once again, needed for shelving decisions.

Binding policies are usually fixed rather than variable or based on usage. "Periodicals that are received in parts (e.g., monthly, quarterly, weekly) are normally sent for binding when all the parts that constitute a 'volume' have been received."[11] More optimnal binding practices may be obtained if time and priority of binding are based on item demand.[12]

In light of the above and other considerations, the following data on collection use should be collected and reported:

- items circulated, their frequency and reserve queue lengths
- items taken from shelves but not circulated
- items sought but not found in local collection

Reserve queue length can provide timely data on the potential need for additional copies or the need to reduce the loan period. The importance of data on items taken from the shelves but not circulated has been discussed above. The identification of items sought but not found may seem, at first glance, problematic, but with the increasing on-line access to local catalogs and the natural extension to on-line union holdings, the patron will be better able to communicate this information to the local library.

IV. ILS Version 1.0

The ILS is a research and development activity of the Lister Hill National Center for Biomedical Communications, the R&D

arms of the National Library of Medicine. The goal of these R&D endeavours is to explore and evaluate the application of advanced computer technologies to library automation. As a government institution the Lister Hill Center will neither market nor support any products. Rather, it is hoped that these efforts may serve as a model for the library community. The need to have the intimate involvement of a small to medium size library in the ILS development has been satisfied by the very rewarding, collaborative assistance of the Army Library, Pentagon, where ILS Version 1.0 is presently operational. The ILS software and extensive documentation is available through NTIS (National Technical Information Service).

A. Collection Control

The basic design of ILS has emphasized collection control. The requirements for accuracy, currency, and easy accessibility of location and status information have been achieved through the integration of all functions within one system, the integration of all items information within one Master Bibliographic File (MBF), and the implementation of special features such as those highlighted below. All item locations identified in Section II, with the exception of the multi-department or branch situation, are presently implemented in ILS Version 1.0.[2]

1. **Master Bibliographic File (MBF):** The MBF contains all item location, status, and MARC-compatible bibliographic information in one on-line file. This allows easy access to the information by the user and insures the availability of the most current data on each item to all functions. The MBF, with the Catalog Access Subsystem, allows access to the item information based on a large number of entry points including call number (local), LCCN (Library of Congress Card Number), ISSN, author, title, and subject. Each serial record may contain sub-indexes to identify specific issues (and, hence, location and status) by volume or date.

2. **Bar-Codes:** Following a study of machine-readable labels used in libraries,[13] the "Code 39" bar-code was chosen for use in the Army Library, Pentagon. One of the main reasons for choosing Code 39 was its ability to code the full alphabetic (upper case) and numeric character set. ILS supports the generation of the bar-code labels from information in the MBF via a bar-code printer. This provides several advantages. The bar-code can be made to coincide with the unique MBF item identification; up to 3 lines of human-readable information can be printed with each label; and the labels may be "intelligently" assigned.

At the Army Library, the bar-codes are not just sequential code numbers but contain item specific information derived from the bibliographic (MBF) record. For example, part of the code assigned to an item contains a unique title identifier while another part of the code contains the copy number information. Hence, it is possible to trap, on check-in, any copy of a given title by reading the bar-code without having to reference the MBF, or having to store the bar-code for *every copy* of the title in an exception file. Cataloging such "intelligence" into the bar-code offers numerous advantages for collection control including improved processing efficiencies and an improved potential for low cost, microprocessor- based, distributed processing or back up. The latter follows by the ability to identify important exceptions such as delinquent patrons or items-on-hold based solely on the local storage of unique bar-codes. Even for large libraries, the computer storage requirements for such exception lists are within the range of presently available, low cost storage modules. And finally, though not required, the utilization of machine-readable labels makes it possible to maintain more accurate and timely location data with less effort.

3. **Cart or Temporary Location Function:** Due to the lack of statistics, the reference librarian can only estimate the frequency with which NOS (not-on-the-shelf) items are eventually discovered on a book cart awaiting re-shelving or technical processing (e.g., cataloging, binding). The CART (or temporary location) function within ILS was designed to fill this common

gap in location information. As currently implemented and utilized at the Army Library, Pentagon, each cart and/or temporary location has a machine readable label (bar-code) affixed to it. A unique name is also printed on the label (typical names: MAE WEST, R2D2). As the items are checked in they are placed on one of the book carts. The name of the cart and its destination are logged by the user. Should any staff member or patron attempt to determine the status of an item which has been checked-in, but not re-shelved, the item status will indicate the name and location of the cart on which the item resides at that instant. The reference staff at the Army Library have found this function very effective in immediately servicing requests that would have been otherwise delayed or unfulfilled.

The cart subsystem is also utilized for the day-to-day operations within the technical services area, where items may sit on various carts or shelves for a few hours, several days or even weeks. When the items on a book cart have been re-shelved, a single command, combined with reading the bar-coded cart identifier, restores the recorded status of all items to their proper location. While no quantitative data have yet been gathered, the experience at the Army Library has indicated that knowing the location of items that would have previously been identified as NOS has had a positive impact on improved library service.

4. **Inter-library Loan:** Items borrowed on inter-library loan (ILL) are entered as temporary items controlled in the same way as any item permanently in the library's collection. Photocopies may also be assigned a machine readable label and made part of the permanent collection. The ILL Subsystem can capture the ILL request on-line, and in the future, will be able to print the request or electronically transmit it to another library.

B. Collection Management Support

Without doubt, the greatest benefit of an integrated library system will be in the area of improved collection management.

Both the present need and potential benefit are greatest in this area. Some of the more salient ILS features relating to decision support, and, hence, collection management, are serials check-in, the shelving function and usage statistics. While the serials check-in is, itself, not a decision support function, it is an important functional antecedent to both the Shelving function and Usage Statistics to be addressed below.

1. **Serials Check-In:** Serials check-in is performed on-line. During the check-in process, the MBF is updated and, at the Army Library, a bar-code label is printed and attached to the issue to allow immediate item control. The locally printed bar-code label is generated from information in the MBF and contains three lines of human-readable information, the journal title, ISSN, and VIPS (volume, issue, part, supplement). At the same time, a routing slip may be printed for either further technical processing or pre-assigned user routing.

2. **Shelving Function:** As previously discussed (cf. Section III), a major gap in most usage statistics in the in-library use. Within the biomedical community, numerous libraries do not allow journals to circulate. The bar-coding of periodicals and monographs affords an easily used, low cost method of maintaining in-library usage statistics. In ILS, the item status record maintains separate in-library use and circulation statistics.

3. **Usage Statistics:** A study sponsored by the Council on Library Resources[14] investigated the collection and use of statistics at 25 academic libraries where automated circulation systems were operational. The results were disappointing in terms of the data collected and their limited application to library management. In the deisgn and implementation of ILS, a concerted effort has been made to provide for the collection of appropriate statistics. Wherever possible, the librarian has been given the ability to control the collection and display of statistics by user defined parameters. For example, the librarian may modify the frequency with which statistics are gathered as well as the length of time (years) they are archived by simply designating easily adjusted circulating parameters.

Since efforts at the Lister Hill Center have been absorbed in the design and implementation of these capabilities, the potential of their utilization for more effective management has not, as yet, been fully explored. The present products are a series of on-line and hardcopy reports.[15]

V. Planned ILS Features

Many features of ILS which are either in process or planned will extend the librarians capability for improved collection management. These features include the patron catalog access, portable data entry terminals, and system network access.

1. **On-line Catalog Access:** On-line catalog access planned for the patron will provide critically important information on catalog usage. It is expected that the potential for collecting detailed data will allow the initiation of studies to resolve questions which heretofore have been the subject of debate. Previous catalog use studies[16] have been impeded by the need for personal intervention and obtrusive questionnaires, and sampling errors.

It is also planned to elicit from the patron the identification of items desired but not found in the collection. The on-line access to a union catalog and shared serials holdings data base with potential for automatic initiation of an ILL request (see "System Network Access" below) will greatly enhance the accrual of this type of information.

2. **Portable Data Entry System:** There are several functions within the library that could be greatly facilitated by the use of a hand-held data entry device or terminal. One is the "Shelving Function" addressed in Section II. The availability of a portable (preferably hand-held) unit would preclude the need for bringing the items to a site remote from the periodical rack of stacks for wanding.)

Perhaps the most important potential application is the inventory function. Most libraries rarely conduct a complete inventory of the collection. To do so by conventional manual methods is laborious and error prone. Recent developments offer the potential for storing portions of the shelf list locally in a hand-held device and identifying shelf sequencing problems as they are encountered. Such an application is currently under development at the Lister Hill Center. Implicit in this application is the need to achieve a valid Call Number sort, a problem also being addressed by the Center.

3. **System Network Access:** A basic design objective of ILS[17] has been "system network access." By this is meant the ability of the *system* to automatically connect itself when required to external library network resources to support shared cataloging, access to union catalogs, shared serials holdings, access to on-line book dealers, etc. One area of potential importance to collection management, not previously emphasized, is network access to shared serials holdings information. The decision on when to claim a missing (not delivered) periodical is hampered by many factors such as irregular or late publications and mail delays. A simple and unambiguous criterion for claiming an item is: "If other libraries have the expected item, and we do not, claim it!" System network access to a shared serials holding file, such as that available in the biomedical community (PHILSOM III[18]), would allow and encourage utilization of this simple criterion.

VI. Conclusion

A major goal of library automation today should be to improve collection control and collection management. The authors firmly believe that the automation of the circulation functions without attention to the broader aspects of collection management and control is no longer justifiable. It is hoped that the experience gained with the features of ILS which are designed to promote these goals will provide a model upon which others may improve.

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Developing and Transferring An Automated Library System

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Before discussing the development and transfer of a locally and programmed system, I shall describe the basic system itself. In 1970, at The Ohio State University, the University and the Library drew up a set of specifications for an on-line remote access circulation and bibliographic access system which entailed a short record of about 100 characters comprising the author, title, date, holdings, call number, and LC card number of each item owned by the University Libraries. That system, the Library Circulation System (LCS), was further refined and a contract was awarded to IBM to develop technical and design specifications and to perform (upon approval by the Library of the specifications) the actual programming and coding of the system. Such was done, and the actual work required 5 people for 18 months. The job came in on time and within its budget. Some 90 man-months were put into the system itself — that is 7½ man-years of labor was required to implement the progrtam and start the original system. After that, approximately 2 to 3 man-years have been expended by each institution using it in maintenance, enchancement, and further development.

Obviously over the years much more programming effort has gone into modification and improvement than was required to build the original system. Since it has been transferred to at least two other institutions, (possibly three — we are not quite sure whether the last institution which received the source code actually implemented the system), we can estimate that something over 25 man-years of such development has occurred.

Among the changes that have occurred at one institution or another (given the locally modified and enhanced activity which has been going on over the last 8 or 9 years, such differences are inevitable), The Ohio State University has added routines for serials control. Although the system does not yet have the provision for individual serial issue check-in, it includes more precise searching of serial titles than the regular search routines call for, and the searching of serial titles only rather than all titles within the master file. That institution has also added the option of using the full bibliographic record and providing searches on the subject heading, thus providing subject access as well as the author-title access. In Illinois we have provided programs which are applicable to multiple institutions and multiple campuses of individual institutions, each with separately addressable files and a concurrent controls search routine and the like that goes with such a system. Furthermore, a separate author search was programmed. SUNY Albany has provided programming for a library using accession numbers as unique identifiers.

The system has been changed not only in its basic programming, but it has been transferred from one model of an IBM machine to another. It started out on an IBM 360/50, was transferred to a 370/155 (later 158), and was moved when it went to Illinois to a 360/75 and then to a 370/168. I do not know which machines it has run on at Albany, but I am sure that some variations of the machines I have noted were used there as well.

When it was started at Ohio State, there were a little fewer than 100 terminals. Now in Illinois in the multi-campus environment, there are some 300 terminals dedicated to LCS, and the transaction load is approximately 1,500,000 commands per month. The system that runs on the 370/168 is using about 10.3% of the CPU for the on-line processes and 1% of the batch processing time of the center for the off-line requirements. While this has grown some from those original programs, it is not a phenomenally high usage of the machine.

Among the comments one might make about locally developed systems and the transferring of them are the following: First, if programs can be changed, they will be. That is, one of the advantages (or disadvantages if looked at from another angle) of proprietary systems or commercially available systems is that the options to make changes are limited enough so that stability is much greater and one has the ability to hold to minimum changes. Obviously no system fits all local requirements exactly, and therefore the urge to make systems fit the local requirements rather than to change the requirements is a continuing pressure on managers of such systems. The discussions about such changes and about library policies are enormously time-consuming, and one discovers that if the option of change is open, even minor changes in library policies may be fraught with political implications which are sometimes insurmountable. Thus we have a multitude of every minor variations in loan period, fine policy, save routines, patron notification, and fine notice schedules, and the like.

Another problem with locally transferred and maintained systems is that the inelegancies are obvious to all, and that each group of programmers and computer center personnel have a terrible urge to "neaten up" any programs or systems that they can get their hands on.

Lastly, such systems require extremely good documentation — more so than the commercially available systems, since the local programmers must work with changing systems rather than simply maintaining stable systems, as in the case of the commercially available kinds of library automation.

Each of us on this panel has been discussing the fiscal implications of automated systems, and to that I can but add that we have not saved any cash, but have incurred some real and demonstrable cost avoidance.

While we are waiting for the appropriation to come through for a new stack addition, we have been forced to rent storage facilities and to store approximately 100,000 volumes each year from our main stacks in the storage facility. The costs of that transfer have been (excluding the rental of the space itself) approximately $30,000 a year for the changing of records, the shipping of materials, and the retrieving of them from the remote facility. This figure would have been at least twice that much if we had not had an on-line system which would allow such changes in location to be displayed completely and provide patrons and library staff accurate location information. If we had had to change every shelflist card and modify the circulation department's own records, the costs would be very close to $60,000. When the remote storage facility is no longer needed, we hope to be able to reduce some of that staff time, but I am not always confident that that kind of saving can be effected once the people are employed by a unit or institution. Work seems to occur and need seems to raise the priorities to meet the budget available.

The biggest increase in cost has been in postage. For the first time, accurate and complete overdue and save notices go out in a timely manner. In the old days overdue notices were often skipped or mailed out once a year. This actually kept the costs of mailing down significantly. Now with extraordinarily regular and full notice printing, a much faster return of materials and far better control of the collection has been insured although, at the same time, there has been a very significant rise in postage costs. Of course, some of this is attributable to the rise in postage itself, but on our campus at least, only some 15% of the messages have to use U.S. Mail; the rest are sent through campus mail.

The supplies needed for the system are almost equal to the supplies needed by the manual system — that is, the paper used by the printing terminals, even though there are significant increases in circulation, about equals the amount of expense in McBee cards used by the manual systems.

The last item is that the circulation does in fact go up. Our circulation has gone up 20% in the last two years, based on the circulation during the month of October. We have not increased the budgets of the circulation departments, so obviously there is a reduction in the unit cost per item circulated for the library.

The data and the system are separable issues, and I do wish to make a comment or two about the data themselves. One is that it has been my experience that there is no truly happy occurrence of "on-the-fly" conversion of library records. In almost every case where a library has done so they have been dissatisfied and the project has dragged on far longer than was believed when planned. Furthermore, it does prohibit the use of these full inventory systems as searching devices and bibliographic tools. It is far better to spend the slightly extra time in doing full conversions than to convert items as they circulate or are returned.

Secondly, the use of OCLC seems to be the most satisfactory for smaller projects — that is when the library has fewer than some 500,000 or so titles. The advantages of doing the conversion through OCLC and obtaining a full MARC record as a product or by-product seems to be well worth the effort. For large libraries who cannot spend the time or the labor in doing such conversion through OCLC, outside vendors seem to be satisfactory. One does have to proofread their work, but the work is reasonable and reasonably accurate, and appears to cost approximately 15¢ per record for 100-character records drawn from the shelflist. At these prices, most libraries can do significant conversion projects and not have to rely on converting only small portions of their files.

There are some other questions surrounding the use of all automated systems, not simply those which have been locally programmed and are transferred. One is, of course, that privacy becomes a genuine issue when dealing with large name and address files as circulation systems must. Each circulation desk throughout the system (in fact, throughout the state) wants to know, and believes it has a real need to know, the actual name, address, and status of each patron. LCS does check the validity of each borrower and charges books out with the appropriate circulation period depending on the status. However, that is not for most circulation departments, and they seem to have a relatively good case, especially when they are trying to recall or judge the efficacy of the placing of a save on a given item that is already charged out. Any system which has public terminals will have to suppress the identification number of patrons who have books charged out, and of course that is done with LCS. An indication of charged out plus the status (faculty, student or other), and the campus upon which the borrower is located does have to be displayed so that a patron can judge whether or not the book will be back in some reasonable time.

There is some real reason to believe that the retaining of the data about who borrowed what over any period of time other than the actual loan period may well be counter to the best interests of the academy. That is, we have seen in the past members of federal agencies requesing such information, and I believe that it would be better not to retain such. At the moment LCS substitutes a departmental code for the person's identification number in the history tapes, we are unable to answer questions about who borrowed what in the past.

Lastly, there are certain topics for both research and management that the analysis of the kinds of records and statistics kept by automated systems will enable us to do what we never have been able to perform in the past. For instance, one can do an analysis of whether items with corporate entries are borrowed significantly more or less often than items with personal authors. I believe that the items which have corporate authors are borrowed far less often than the items which have personal authors, and that that is a significant factor. We all know that the cataloging expense and time is much, much greater for items which do not have personal authors than for those which real people have written. It may well lead to management decisions about cataloging which run counter to the generally accepted practice.

One area of research may also be in the area of collection development wherein one analyzes the actual number of items used, as a percentage of the total holdings in a given field in order to discover, for example, whether more duplicates are needed rather than fewer. One can analyze the patron types and usage as well as the types of books and their usage. Thus a clear picture of whether faculty, graduate students, and undergraduates have different reading habits, different levels of intensity, and the like, can be proved or disproved.

In conclusion, we have demonstrated that viable systems can be locally designed and implemented, and can be transferred. The decision whether to implement an available system or to build one's own is one which itself must be done in each local institution. There is no generally "right" answer.

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University of Guelph On-line Circulation and Inquiry: an In-House Alternative

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The University of Guelph Library has had an on-line catalogue and direct user inquiry system since 1977, although the initial stated requirement was for an on-line circulation system only. In order to explain how an on-line catalogue evolved from a circulation system it is probably necessary to provide some background information.

The University of Guelph, a medium sized agriculture and science based university some 50 miles from Toronto, has used library developed computer based systems since 1966. By 1976 there were separate systems for the cataloguing/processing of maps, documents, serials and books, as well as for acquisitions and circulation, all running off-line on the University central computer (IBM 370 155). At that same time, the Library circulation terminals, Mohawk C-DEK's had become obsolete and beyond repair, and it was necessary to find a new circulation system.

With the state of technology moving so rapidly it seemed foolish to contemplate other than an on-line system. Accordingly, we explored the market place of turnkey circulation systems and reached the following conclusions.

1. No turnkey system on the market at that time encompassed all the features which the University of Guelph Library included in its design specifications.

2. Any turnkey system studied would have imposed changes on the internal library staff organization, on existing circulation procedures, and on library use regulations previously approved by Senate.

This latter would have been most serious, since the library would have been placed in the position of going to Senate and requesting changes in Senate policy, not because the regulations were philosophically wrong, or even outdated, but because a computer system could not handle them.

The decision was made, therefore, to develop the system locally, and the Library entered into agreement with a Canadian computer company, GEAC. Using a team of four systems analysts (2 from Guelph, 2 from GEAC), and working very closely with librarians from the circulation, acquisitions and cataloguing departments in the University of Guelph Library, had the system operational within 6 months. By the fall semester, 1977, an in-house system had been installed which not only met all the basic circulation requirements, but also provided the capability for coordination with cataloguing, acquisitions, serials, documents and map systems. In fact, since the circulation system operated from the library master file of MARC compatible records it was possible to implement immediately several catalogue maintenance functions, such as adding copies and volumes or correcting record errors.

Most important, however, was the public inquiry function, and this is how the on-line catalogue was established. The inquiry module of the circulation system was designed with self-instructing display screens which lead naturally and sequentially from one command, instruction, or question to another. Each set of functions is displayed in a menu, from which the user selects the key which he desires. After locating a wanted title, (either book or document), the user can then move to another set of functions which allows him to determine location status or loan period for the title. If it is out in circulation he can place a hold on it and even indicate the date after which the books would be useless to him. The user may also inquire about his own borrower record — whether he has books out, when they are due, the amount of fines owing, holds he has placed, if holds are available, etc.

It was originally assumed that this circulation inquiry function, which is called 'Borrower Inquiry,' would be the most important feature of the public inquiry system. How quickly this was proven wrong, as the students discovered that they could use the terminal as a catalogue, paging back and forward, finding wanted books or documents through author, title or call number. The number of public terminals was doubled, (there now are 12 in the main library), and recent user studies show that 75 per cent of Guelph users prefer this access tool, incomplete as it still is without true subject or reference structure, to the card catalogue. Decentralized access is also available, since the library system is connected through a Gandalf network to all standard ASCII terminals on campus; and via DATAPAC to any ASCII terminal in North America.

System developments in the University of Guelph Library have continued since 1977, so that the acquisitions' module is now operational, with 'on order' information also part of the public inquiry system. The cataloguing module which is in development includes authority control and reference structure; brief or full record options; boolean search strategies; both menu and command functions; forward or backward browsing; and the integration without conversion of all record formats — books, serials, documents, or maps.

Two other features which an 'in house' circulation system can perform in superior fashion to a turnkey system are security control and collection management.

The University of Guelph Library or GEAC system accomplishes security in several ways.

(i) Specific functions can be assigned to specified terminals, only. These can be varied according to time of day or to meet management requirements. For example, the public terminals can only be used for two functions: Borrower or Book Inquiry. Staff terminals used for catalogue or circulation maintenance functions in public service areas during the day are changed for the evening or weekend hours to Borrower or Book Inquiry functions only.

(ii) Important functions can be limited in their use to designated staff members. This feature is controlled by the staff member's bar-coded badge. The level of access is related to his or her bar-code number.

(iii) Pass words, changeable at any time, provide a third level of protection.

The Guelph system's security depends on the COD-A-BAR label system, which provides a high degree of accuracy and flexibility. In addition, the computer operating system is insulated with an intervening level of programs, ensuring that the integrity of the bibliographic files as well as the privacy of the borrower cannot be compromised.

Collection or inventory management has been the goal of librarians since the era of the chained book. In addition to the traditional library functions of cataloguing, which identifies what should be in the collection; of acquisitions, which determine what is about to be in the collection; or of circulation, which establishes what is in the collection but is out in use; a good collection management system should be able to:

(i) identify items experiencing high usage and either change the standard loan period from two weeks to one week or two hours, depending on an algorithm, and/or initiate an order for additional copies.

(ii) maintain an accurate statistical picture of library use, not only of those items out in circulation, but also of those items used in the library.

For instance, with bar-code labels in each volume or periodical issue, on each reel of microfilm or binder of microfiche, a simple wanding of the label before material is returned to the shelf will give you a count of most in-house use. Such a system depends on the user not reshelving his own books. Guelph has long encouraged this practice through the use of brightly coloured shelves in every range, clearly marked: *Please leave books here for reshelving.* These books as well as books left in the carrels, are picked up every hour and taken to a sorting station, one on each floor of the Library, which is equipped with a terminal and light pen. After wanding, the books or journals are sorted and reshelved. The transactions thus recorded supply accurate information about in-library use that is increasingly important to have, for two reasons:

(i) budget reductions force us to define criteria for retaining one title rather than another.

(ii) space is becoming as critical an issue as budgets, as many university libraries find it necessary to decide which periodicals or books can be moved from the main or branch libraries to less expensive storage space. Previously libraries determined use of the non-circulating collection, through sampling, but while a useful indicator it was not the kind of factual data needed for long range space planning. An intelligent weeding policy based on the now available use data can be developed within a space program.

The fact that the library user can have much better information about the location of the university library collections whether in the central library, in a branch location, or in off campus storage, will alleviate the perennial concern about storage libraries. If the user can call up the title on a terminal, see that it is in another location, and through placing a hold have it brought from storage for him, he will be more than satisfied with the library system.

Analysis of use of collection formats is another benefit of the collection management aspects of an on-line circulation system. For example, if a library keeps recent issues of a non-circulating periodical in hard copy but older years in microform, analysis through the wanding of returns of the use of both formats should determine if there is an inordinate discrepancy in use the year the format was changed from print to microform.

Standards for shelf maintenance can also be established, since the wanding gives accurate counts of items reshelved, with the time period or even staff member identified, if desired.

If library bar-codes the entire collection in a planned and intelligent fashion, and if an electronic detection system is coordinated with the circulation system, the periodic stock takings which used to occur should be redundant. The call number sequence of the bar-codes is your total shelved collection. It should be possible to assume that if not out in circulation, the item is on the shelf or in use in the library. However, if a library decides that a full or partial (sample) stock taking is necessary, it will be greatly simplified with a portable label reader.

The impact of the collection management aspects of the Guelph on-line circulation system have been quite dramatic in that they have increased confidence in the library system. The reserve collection is smaller, more relevant and better used. The faculty are able to plan courses based on data about the use of the library resources, particularly in the reserve area. The library acquisition and weeding programs, within the financial and space restraints under which Guelph is operating, are understood if not welcomed by faculty and the University administration. Through the responsive and changing loan period, books are in the library when the students need them, and in as many copies as that need has defined.

It is some of these management features, as well as the on-line catalogue, the acquisition system, and public inquiry both in the library and dispersed on the campus, that would not have been possible with a turnkey circulation system.

One of the primary objectives of an academic library administrator has always been to manage his own resources, staff and budget, so that the collection and services which meet the requirements of faculty and students are available and accessible when they are needed. In adopting new technologies to assist in meeting that goal, much of what has been done in the past two decades has been based on unproven assumptions or on decisions copied from other university libraries.

Without accurate data about library use or of costs associated with that use, it has not been possible to fine tune and justify collection policies, space programs, or staff requirements. Without in-house expertise in library automation it has not been possible to develop library systems responsive to local needs. Librarians have become mired down in conflicts over AACR2 and network governance, dependent on decisions taken by other librarians, by politicians, by bibliographic utilities, or by turnkey vendors.

At the University of Guelph the local development of an on-line circulation system, which evolved from previous experience and which is progressing into an integrated system encompassing all library functions, has allowed us to maintain the kind of independence that is essential, if the needs of our users are to be maintained as our first priority.

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Microfiche and the Duplicating Library Concept

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For decades microforms have been touted as the answer to the problems inherent in the storage and use of growing volumes of holdings in libraries. Beginning in about 1950, libraries turned to microform technology as an administrative solution to the difficulties of acquiring and storing materials. The literature was rife with articles proclaiming microforms the panacea for growing space, acquisitions, and service costs during a period of financial austerity.

Estimates of space savings of microforms over hard copy ranged from 85 to 98 percent, with a cluster in the 90-93 percentiles.[1] Comparisons of the costs of micropublications and paper publications indicated that the micropublications were substantially cheaper. Evaluation of service costs demonstrated the advantages of microforms in terms of circulation, preservation, and replacement. Micropublishing flourished, and libraries acquired microforms at astonishing rates. By 1979 university research libraries held a total of over 133,000,000 microform units. Their median holdings in microform rivaled those in paper: 1,179,000 microform units versus 1,742,000 volumes.[2]

However, in the late 1960's and 1970's, articles in the literature began to suggest that the utilization of microforms in libraries did not appear to be as successful as had been anticipated. User response to microforms was termed negative. We learned why. We learned that we had failed to apply a systems approach to library microform handling and use centered around user needs. Our loose application of microform systems components resulted in user prejudice against the entire concept.[3] Our collection development efforts did not focus on the value of the information to the user. Instead of providing current and relevant materials available through advances in micropublishing, we acquired low-use and specialized material in microform. We did not provide the user with identical bibliographic access to both hard copy and microforms; instead, in most cases, we provided inadequate, or no, access to our microform collections. We did not design and administer microform service areas so as to provide an optimum physical and psychological environment for microform use. Instead, we offered physical facilities which were remotely located, inadequately lit, and aesthetically inferior to other library areas. And, finally, we confused the user with a plethora of microformats — microfilms, microfiche, micro-opagues, aperture cards — and with the associated range of highly individual equipment. This equipment, all too often, was outdated and poorly maintained.

Articles in the literature did not cite only user resistance as the reason for the less-than-successful utilization of microforms in libraries. They also suggested that the anticipated savings in space, acquisitions, and service costs were not being fully realized. Projections of space savings had not always taken into account the space required by reading and storage equipment and service areas. Nor had it been anticipated that libraries would acquire such a range of microformats necessitating an unexpected and space-consuming variety of reading and storage equipment and larger service areas. Furthermore, it had not been foreseen that few libraries would use microforms to compact collections through large scale conversion of existing collections on paper to microform.[4] Planned savings in acquisitions costs were diminished when libraries sometimes acquired the same materials in both hard copy and microform or continued to bind serials also held in microform. Contemplated savings in service costs were lost in those libraries which chose to circulate microforms and, consequently, found themselves having to replace lost or damaged microforms.

It appears now that the application of microform technology has not lived up to our expectations and that libraries are still faced with the continuing growth in output of published information coupled with an ever-increasing demand for these sources of information. These problems are compounded by the fact that, as a library increases in size, it becomes increasingly important to retrieve materials more economically and more rapidly. Yet, there is an inverse relationship between the size of the collection and the retrieval time required.

Ironically, microform technology still holds the potential for resolving these difficulties to a meaningful degree. Currently microforms are the preferred medium for text storage in terms of cost, space, and technology. However, the application of this technology in libraries must rest on its own merits as a communications medium for information control and dissemination rather than reflect an administrative solution to the problems of storing as opposed to disseminating materials. Such an application, accompanied by a sensitivity to the needs of the user, could result in a utilization of microforms that would benefit both the library system and the user.

Since the past failure to utilize microform technology effectively in libraries is largely of our own creation, we still have the opportunity to apply it successfuly as an information handling and retrieval medium in libraries. We know from our experiences that such an application requires a total systems design that incorporates user needs. The key variables of user acceptance have been determined and can be provided for in our design of microform facilities and in collection development efforts. Richard Boss of Information Systems Consultants, Inc., has just described for you the approaches developed, in his one year study, to resolve the problems of bibliographic control of microforms. We also now recognize that the proliferation of microformats and their respective equipment confuse and frustrate users. Once these factors are addressed adequately, microform technology can be utilized to its full potential as a medium for information control and dissemination.

In an important paper delivered at the 1962 meeting of the National Microfilm Association, Laurence Heilprin, then of the Council on Library Resources, outlined such a utilization of microform technology.[5] He described the concept of a duplicating library in which an inviolate collection of books and other materials, in microfiche, is never circulated but, instead, is duplicated on demand through fiche-to-fiche copies.

The characteristics and economics of this concept and its potentiality for improving the storage and retrieval capabilities of libraries and for meeting the needs of users as well as libraries will be discussed in this paper. Because the concept and its ramifications are complex, it is necessary to set forth a simplified and idealized representation of the microfiche duplicating library. It is important to note first that the duplicating library concept is limited to microfiche. This limitation applies because only fiche-to-fiche duplication is economically feasible for microform consumers. In addition, because microfiche is a low capacity microform, it is the most appropriate dissemination medium (with the exception of aperture cards) for supplying "on demand" copies of single units of information to meet specific user requests.

Following is a general idea of how the duplicating library works. The user learns through the library's bibliographic access system that a desired item is held by the library in microfiche. He then goes not to the stacks, but to the microform service area and makes his request for the document. The person staffing the area retrieves the fiche and, using a microfiche duplicator, duplicates the microfiche on demand through diazo or vesicular fiche-to-fiche copies. The copying turn-around time for one fiche is approximately 30 seconds. The microfiche is not circulated. Instead, the user receives his own non-returnable copy of the material. The library copy of the microfiche is returned immediately to the file, where it is readily available for the next request.

Two characteristics of the duplicating library make it very attractive economically: the microfiche is duplicated rather than circulated, and the concept is limited to the microformat of fiche.

The economic advantage of duplicating documents rather than circulating them was outlined by Heilprin in his NMA paper. Heilprin has determined, through a sophisticated economic model based on physical flow, that, if a copy of the item circulated costs less than the cost of its circulation, it would optimize economic costs to give a copy of that item away. Microform technology offered the library the opportunity to eliminate the expensive circulation loop through cheap, give-away, fiche-to-fiche copies.

Heilprin's economic model holds true today. The labor costs involved in duplicating a fiche total approximately 10.3¢ The cost of replaceable materials amounts to about 9.5¢.[6] Estimates of the cost of circulating an item range from about a questionable low of 50¢ to many dollars. It is, therefore, more economical for the library to meet multi-user demands for the same item by making and distributing duplicate microfiche. Because the costly labor expenses are reduced, it is actually less expensive to give away a microfiche copy than to circulate the item.

Recent studies of the automation of the circulation function have confirmed its labor-intensive, and consequently expensive, nature. In most libraries, circulation service hours are long. Controlling circulated items, recalling overdues, and billing users necessitate extensive record-keeping. When circulated materials are returned, they must be sorted and reshelved. Significant costs are associated with binding, repairing, and replacing materials. In combination, these costs may easily exceed the purchase price of an item circulated more than a few times.[7] The cost of duplicating microfiche represents a very small percentage of the fiche's purchase price.

The other economic advantages of the duplicating library derive from the fact that the concept is limited to microfiche. In turn, the microfiche format offers more qualitative benefits for both the library and the user than any other microform. Because these various benefits are both interrelated and dependent on the format of microfiche, they will be covered in a discussion of the desirability of a predominating microformat in a library.

As noted above, a significant factor in the failure of microforms to realize their full potential in libraries was the proliferation of microformats and their range of highly individual equipment. This resulted not only in user frustration and resistance but, equally important, in unnecessary space consumption and capital outlays for the various types of equipment required. Multiple microformats in libraries are expensive —expensive in terms of user resistance, space loss, and equipment costs. If one microformat were to predominate in a library, and if the capability to duplicate that microform were provided, microform technology would hold the potentiality to improve storage and retrieval in libraries. An argument can be made for the choice of microfiche as that predominating microform.

The majority of current library purchases in microform are in microfilm and microfiche. Let us compare the two. Microfiche equipment is far less expensive than microfilm equipment. The microfiche equipment market has become very competitive, due to an increasing utilization of fiche. Even the lowest priced readers, for example, now have features offered only on expensive microfilm readers. Significant technological advances have been made in portable microfiche readers; they are now small, light, and well-designed. There are no truly portable microfilm readers.

The availability of circulating portable readers reduces the number of expensive stationary readers and space-consuming reading carrel areas required in libraries. In the long run, their low-price — slightly more than $100 — will encourage users to acquire their own readers, thus further reducing the equipment costs and space needs in libraries. Stationary microfiche readers and reader-printers are smaller than their microfilm counterparts, and, consequently, are more space efficient. The space efficiency of microfiche extends to their methods of storage. The physical nature of fiche allows for optimal compact, semi-automatic storage. Microfilm is usually stored, inefficiently, in their container boxes on regular stack shelves. The potential for efficient space utilization with microfiche and their equipment could result in the realization of their projected 95% space savings capability.

Another characteristic of microfiche gives it a significant advantage over microfilm: the one-to-one relationship between a microfiche and a document. One microfiche, or set of microfiche, represents one document. Consequently, the storage and retrieval of any one unit is simple and straightforward. Microfilm is referred to as a non-unitized microform. One document represents only a small portion of a roll of microfilm; therefore, a single roll of microfilm can contain many, and sometimes unrelated, documents. Consequently, the user is limited to serial access, and the location of an item on a roll of microfilm requires significant access time. The unit record concept is a very important one to users and the library.

Users are generally attracted by and understand the suitability of fiche as a unit record of documents. They often do not effectively intereact with a roll of microfilm containing many different documents. This lack of utilization makes film-to-film duplication of a single document economically infeasible.

Unitization is also essential in microform information retrieval systems. Microfiche is, therefore, the preferred format for automated selection and retrieval systems. The unit record storage system allows random access, while the non-unitized system requires serial access. The essential distinction between the two is in search speed. Searching the microfiche store takes minutes; searching the microfilm store may take hours, despite the fact that reels can be manipulated at high speed. Updating the microfiche store is simple and inexpensive and does not affect search speed. On the other hand, updating the microfilm store results in an increased number of reels to manipulate, a longer search process to bring related records together, and a greater yearly cost of operation.

In the future, libraries will benefit from technological advances which provide a more powerful mode of text access — on-line retrieval of text from remote locations. The combination of the manipulative flexibility and speed of the computer to systematize data with the economy, efficiency, and flexibility of random access microform retrieval will result in a synergetic system of information control and dissemination for libraries. The unit record — microfiche — is the key to such a system.[9]

Other problems associated with the use of microfilm are not present with the use of microfiche. Because microfilm is a non-unitized microform, the use of one reel ties up other documents and articles. The fact that film cannot be duplicated for use is a serious limitation. Microfilm can't be used outside the library. The master film is subjected to wear and tear when it is used which affects the durability of the film. Microfilm can be difficult to load onto the reader. It can't be requested from remote locations and supplied through campus or through first-class mail. This limits its use in SDI and interlibrary lending.

A number of studies have shown that microfiche is the most suitable microform for the overwhelming majority of library micropublications. During the past decade micropublishing underwent a radical change. Microfiche has become an increasingly popular medium for publication. While microfilm is now favored for retrospective micropublising, microfiche is usually the preferred medium for both original and simultaneous micropublishing. In fact, some materials are now published only in microfiche. One reason for the growing popularity of microfiche for presenting material is its inexpensive cost, which can be as low as one fifth of the cost of publishing the original. Another is the ease with which constantly evolving or changing data bases can be revised or added to through microfiche. Standards, manufacturers' catalogs, publishers' catalogs, manuals, and college catalogs are examples of frequently-updated services. Serials are another example. Microfilm can only be issued after completion of a serial volume and of the reel itself; this causes a long delay. Microfiche, on the other hand, is updatable and can be published simultaneously with an individual issue. This provides immediate access.

A caveat must be issued here. A few types of material, such as newspapers, are suitable only in microfilm, not microfiche. Certain other types of material are not amenable to publication in microform at all. Reference books should rarely be purchased in microform, as well as original manuscripts, books of art reproductions, some humanities and social science works, or other books in which the quality of illustration is important.

Creative publishing concepts in microfiche have led, and will continue to lead, to the enhancement of the information value of materials in microform. As we now know, the value of the information on microform is a key variable of user acceptance. When the information contained in microform materials is consistent with limited usage, use is exceptional, not routine, and consequently frustrating to the user. The availability of current and relevant material in microfiche is bringing about a change in the pattern of use from exceptional to frequent and routine use.

The user, as well as the library, benefits from the duplicating library concept. When the concept has been applied in libraries, it has had a significant impact on user acceptance. Almost every user study of microform acceptance, where the prevailing medium was microfiche, has found that the acceptance of and a growing preference for microfiche resulted from the operation of a duplicating library that circulated portable readers. The users reported that the combination of non-returnable fiche copies, rapid document delivery, guaranteed access, and circulating portable readers eliminated the disadvantages and emphasized the advantages of microfiche.

Although its impact on user acceptance of microforms has not yet been carefully evaluated and measured, improved document delivery capability is not likely one of the most important features of the duplicating library. Because the microfiche file is inviolate, the desired item is always available and access to it is guaranteed. Copies made on demand eliminate the time-consuming, and often futile, trip to the stacks and the turn around time for copying a fiche is only 30 seconds.

We know that, to the user, stored information is only as valuable as it is accessible. As F.W. Lancaster has said, the principle criterion by which users judge a library collection is its document delivery capability — the proportion of demands for materials it is able to supply.[10] Competition for access to library collections has become severe in the last few years, with the result that access to many materials is uncertain and slow. While it is impractical, expensive, and probably ineffective, to provide file integrity through purchase of additional hard copies of every book in the collection, immediate guaranteed access can be provided effectively and economically through the use of microfiche copies. This fact may well encourage user support of microfiche.

Outlined above is a system for controlling a large and growing information store that not only saves space but also improves access. Lower costs as well as improved services are realized with the microfiche duplicating library. It is sufficiently simple, responsive, flexible, and interactive to overcome user resistance and increase the frequency and depth of use of microforms. When supported by an effective program of microfiche collection development, it can increase the value of the information stored to a degree that would more than justify the cost of its installation.

The challenge at this point is to anticipate the long-run imperatives resulting from the exponential growth of libraries and see them as an opportunity to improve the organization and transmission of information. In the future, microfiche, as a medium for both storage and retrieval of information, will play an active role in the information transfer process in libraries.

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New Technology for Storing, Retrieving and Disseminating the Professional Literature

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Technologies in existence and under development offer substantial potential for altering the way in which libraries deal with serials holdings. The technologies involved include:

- Optical-disk-storage systems
- Data-compression techniques
- Solid-state and optical (laser) scanners
- Electrostatic and laser printers
- Digital-communication systems

The capabilities and limitations of these technologies in the context of library operations are discussed in the early part of this paper. The latter part develops the theme that, in order to take full advantage of these technologies, libraries should give serious consideration to making major changes in current practices pertaining to the borrowing and lending of their serials holdings.

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OPTICAL-DISK STORAGE

Information in digital form can now be stored on plastic disks. In this technology the zeroes and ones representing information in binary form are implanted on a plastic disk, sixteen or so inches in diameter, by means of a laser beam. The presence or absence of small holes or pits approximately one micrometer in diameter represents ones or zeros. High packing density and low-storage cost per bit are the attractive features of this storage medium. A single disk can store nearly 10^{11} bits of information at a predicted cost of about 10^{-8} cents per bit. In terms of documents that are scanned and digitized retrospectively these figures equate to an ability to store approximately 25,000 pages of text and graphics at a disk cost of less than 1/10th cent per page.

In an operational environment it is reasonable to require that a storage device be handling at least 2.5 million pages, equivalent to about 250,000 journal articles. Hence, 100 disks are needed. At present, multiple-disk optical storage systems are not on the market, but designs for handling up to 100 or so disks exist on paper. Since implementation of designs is highly dependent upon the emergence of a market of sufficient size to warrant investment in development costs, it will likely take five or more years before mass archival optical-disk storage systems become available in the marketplace.

DATA COMPRESSION

There are several reasons for storing information in digital, rather than in analog (image), form. One is that technology is available in the digital domain that permits compaction of the data through use of efficient digital codes. A short code is used to describe non-information-bearing parts of a page, (the white part), while longer codes are used for the information-carrying parts. The compression factor thus gained depends on the "busyness" of the page, and depending upon the elaborateness of the coding scheme, compression factors from three or four to twenty or so are possible. However, the more sophisticated the coding scheme, the more complex are the electronics needed to achieve it. Nevertheless, a data compression of ten means that a single optical disk can accommodate ten times more pages of information than is possible under uncompressed conditions. Thus, through data compression, the amount of data that can be put on a fixed number of disks expands by a factor of ten.

SCANNERS

Retrospector digitization of the information content of printed pages containing a mixture of letters, numbers, and graphics, leads to the use of a picture-element by picture-element encoding process. This process is called *scanning*. Coding of complete letters and numbers is possible, but character encoding breaks down whenever graphics are encountered. Simple coding schemes are not available for nonalphanumerics.

The issue of *resolution* plays a key role in the choice of an electronic scanning device. At present, one is hard-pressed to duplicate the resolution quality of photographic film in electronic domain at a price most libraries can afford, but acceptable resolutions are within grasp. First, let us consider resolution requirements themselves. The accepted quality for duplicated materials seems to be that being achieved by photocopy machines, of which the xerographic type is most popular. These machines have a resolution capability of approximately 150 line pairs per inch. (A line pair consists of a black line followed by a white line, each of equal thickness.) With this resolution one can easily read type down to 6-1/2 to 7-point size which is seen as a requirement by many.

Solid-state scanners that can resolve 75 to 150 line pairs per inch are now available in prototype form at relatively low cost. The solid-state sensing elements which are the core of the overall scanner are manufactured to yield a 100-line resolution per unit, and they can be butted together to extend resolution by a factor of two or more. Unfortunately, other elements of the scanning system tend to degrade the resolution of the overall system, with the result that some critics maintain that the quality of the reproduced page is only minimally acceptable. Further progress in solid-state scanners is necessary in order to achieve reproduction quality equivalent to that of prints obtained from microforms, but rapid progress is being made. Furthermore, laser scanners which should completely satisfy strict resolution requirements can be purchased now, but they are expensive.

PRINTERS

Hard copy printers that operate from digital data are also on the market. Printers capable of reproducing digitized alphanumeric and graphical data are of two forms: electrostatic printers and laser printers. The former, which currently cost $10,000 or so, have a resolution quality of about 100 line pairs per inch. Laser printers greatly exceed those numbers both in resolution quality and cost. Clearly, digital printers offer no technological bottleneck to digital storage and reproduction of information, although cost may be a deterrent, temporarily.

DIGITAL COMMUNICATION

As a prelude to a discussion of implications of the new technology for library operation, it is appropriate to cite rapid changes that are occurring in technology for transmitting digital information over wires and through empty space. Digital communication service is available over conventional voice-grade phone lines and high-speed lines. High-speed service is available at 56 kilobits/sec and 1.544 megabits/sec rates. Hence, full-page transmission times can range from a fraction of a second to a few seconds under data-compressed conditions. Phone company tariffs are structured mainly on the principle that costs are roughly proportional to separation distances between end points. However, the trend at the federal regulatory level is toward regulations aimed at increasing competition in the communications field. One consequence of this is that new digital networks have recently come into being with rate structures that are more dependent on message volume than on traversal distances. The packet-switched networks of Telenet and TYMNET are examples of these systems. With this kind of competition, one can anticipate from the users' viewpoint favorable pricing of digital communications in the future. In addition, all networks will have the opportunity to extend their coverage through interconnections with satellite communications systems. Thus, global digital communication is still another technology that becomes available to those who store, retrieve and transmit information in digital form.

ITERLIBRARY RESOURCE-SHARING SYSTEMS

The position taken here is that, in order to take full advantage of new digital technologies, one should think and plan in terms of entirely new procedures for handling library-type information, rather than merely melding the new tecnologies piecemeal into traditional operations.

One example of a new approach is *interlibrary resource sharing* among a group of libraries interconnected electronically by means of a digital-communications network. In this configuration, the *content* of documents would be moved electronically between network nodes, rather than the physical documents themselves or photocopies of segments of documents. Resource-sharing through electronic networks most likely will be applicable to serials holding rather than to books, since interest in serials frequently pertains only to an individual article which can be quickly scanned and transmitted.

Interlibrary resource-sharing networks for serials holdings are attractive because packing density on disks is high since information is stored in digital form. The speed of response to interlibrary requests is also fast; "within moments" for a complete transaction of information already in digital storage is achievable and; "within the hour" is possible for transactions of printed material that must be scanned and digitized on demand.

Clearly, in light of such quick response times, it is appropriate to question the need to replicate all serials holdings at all nodes of the networks. One should also begin thinking about ways to use the interlibrary network transactions records as a means for determining the most effective locations for serials holdings and how the data-gathering feature of the system can be utilized for weeding-out purposes or to relegate certain materials to a second- or third-level demand status.

How information might flow between two nodes of an electronic resource-sharing network is illustrated in Fig. 1. The process starts at the upper left part of the diagram. It is assumed here, for library-control purposes, that all requests for serials flow through the system. In order to obtain a document, the user fills out a request form. (An alternate approach is to have the user insert the request himself/herself at a computer. This approach might be introduced into the system later, after the experience has been gained with network procedures.) The form is given to a library clerk who verifies its correctness. If incorrect, it is returned for correction; otherwise, the information is used to determine whether or not the user's own library owns the document. This step is a computer operation, since a complete index of all serials held by network members will be stored in a computer. Should the document be owned locally, the form is given to the user who seeks it in the stacks. The process ends if the document is found (see diagram); if not, the user resubmits the request form. It is also possible that the local library does not own the document. In either negative case, the clerk ascertains from computer-stored information which, if any, libraries in the network hold the document in question; if none does, the process ends. If one or more do, the clerk enters request data into the computer. The amount and kinds of data that must be posted remains to be decided; in general, the data will depend upon the degree of automaticity that follows in succeeding steps. Two limits are envisioned: At one extreme, the clerk transmits a request message via computer to the library most likely to have the item being sought, repeating the step, if necessary, for the next-most likely source and so on until a supplier has been found. At the other extreme, with a more elaborate computer-file structure, further clerical action beyond the initial entry of a request would be unnecessary except to check on the status of a request. The computer would automatically transmit the request serially to various libraries until the request was honored.

If no supplier in the network can be found, the process ends. If a supplier is located, the request form is delivered to the local transmission operator by the requesting clerk for identification purposes, at which point the local clerk's task ends (except perhaps to enter billing information into the computer on receipt of notice that the document has been sent to the user).

Action is now transferred to the supplier's location (see lower right side of Fig. 1). The supplier's clerk receives the document request from the resource-sharing computer and determines whether or not the item is on the shelf. (We know the supplier *owns* the document; otherwise, that particular supplier would not have received the request.) If the answer is NO, that message is inserted into the computer and the next-most-likely source is tried. If the item is available, it is de-shelved and given to the transmission operator together with the request form. The transmission operator, in turn, electronically scans and transmits the document, after which it is returned to the clerk for replacement in the stacks.

Action now reverts to the requestor's location. The transmission operator there receives the transmitted document, informs the user by phone of its availability for pickup, or delivers it by internal mail and finally returns the original request form to the clerk, who posts accounting data into the computer.

The process as outlined above, is for illustrative purposes only. As implementation problems are uncovered through modeling of computer hardware and software configurations, alternative information flow models processes should be examined.

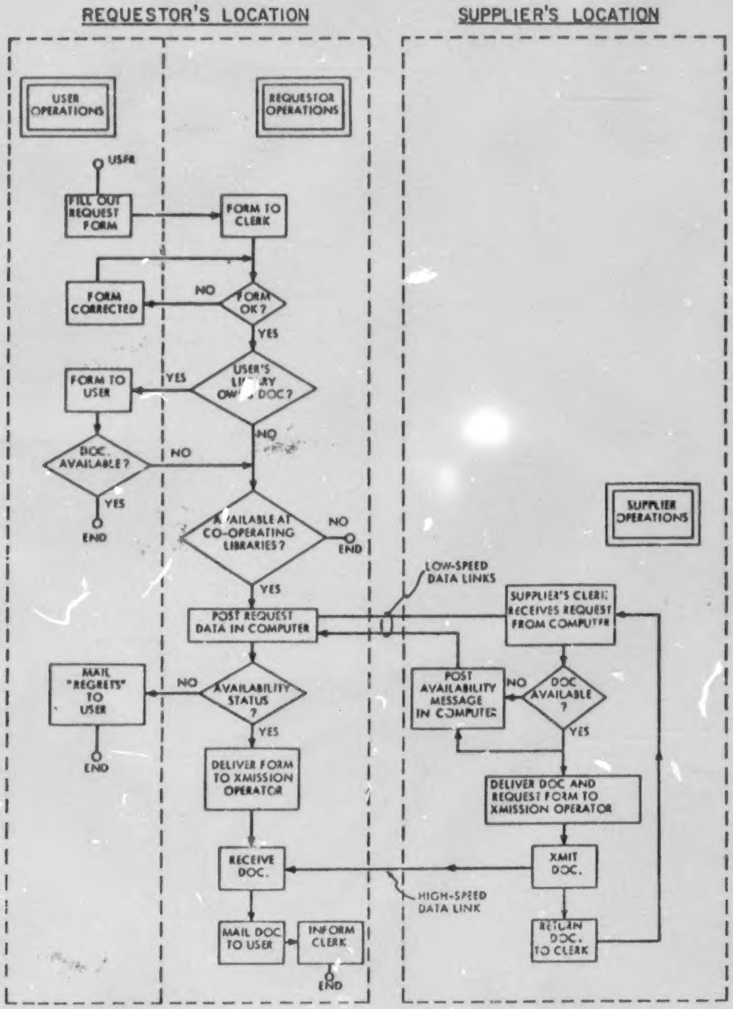
REQUESTOR'S LOCATION
SUPPLIER'S LOCATION
USER OPERATIONS
REQUESTOR OPERATIONS
USER
FILL OUT REQUEST FORM
FORM TO CLERK
FORM CORRECTED
NO
FORM OK?
YES
FORM TO USER
YES
USER'S LIBRARY OWNS DOC?
NO
DOC. AVAILABLE?
NO
YES
END
AVAILABLE AT CO-OPERATING LIBRARIES?
NO
END
YES
SUPPLIER OPERATIONS
LOW-SPEED DATA LINKS
POST REQUEST DATA IN COMPUTER
SUPPLIER'S CLERK RECEIVES REQUEST FROM COMPUTER
MAIL "REGRETS" TO USER
NO
AVAILABILITY STATUS ?
POST AVAILABILITY MESSAGE IN COMPUTER
NO
DOC AVAILABLE ?
YES
END
YES
DELIVER FORM TO XMISSION OPERATOR
DELIVER DOC AND REQUEST FORM TO XMISSION OPERATOR
RECEIVE DOC.
XMIT DOC.
HIGH-SPEED DATA LINK
MAIL DOC TO USER
INFORM CLERK
RETURN DOC. TO CLERK
END

Fig. 1. Information Flow in an Electronic Resource Sharing System

In summary, we are at the threshold of exciting new technologies that offer promise for altering the manner in which libraries deal with their serials holdings. However, a simple substitution of a new technology for an old device or procedure on a piecemeal, one-for-one basis will likely result in improvements in service efficiencies that fall far short of those which can otherwise be obtained. Preferably, careful consideration should be given to replacing traditional procedures with wholly new systematic procedures based upon the capabilities and limitations of the new technologies.

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The Coming Revolution in Document Delivery

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Document delivery, as the term is used in this paper, means supplying a copy of a journal article or technical report to a student or researcher. In the present library setting, the delivery involves locating a copy of the item in a local or a distant library and then circulating either the item or a photocopy of the item. If the item is not in the local library, an interlibrary loan transaction also is involved.

The process of document delivery has not changed dramatically in the last two decades. However, recent advances in communications, printer technology, and computer software promise dramatic changes in the next decade.

OCLC has already had a significant effect on the interlibrary loan aspect of document delivery. The OCLC On-line Union Catalog has approximately 74 million holdings location symbols, and system interlibrary loan messages can be routed among over 2,3000 libraries throughout the country. Participating libraries have reported that interlibrary loans using OCLC's system take approximately half the time of the U.S. mails. This means that a typical interlibrary loan, instead of taking two to four weeks, takes only one to two weeks using a greatly improved communication message switching service.

Developments described in this paper will help estimate the remaining one to two weeks needed to delivery a document and have the potential of making documents available literally minutes after they are requested. This paper is primarily concerned with the software that will enable documents to be delivered "instantly"; however, first there is a review of the hardware innovations that have stimulated the software developments.

Communications

The technical developments that are bringing on a revolution in document delivery are being driven primarily by the increasing capabilities and decreasing costs of microcomputers. From an increase in satellite communications to improvements in inexpensive acoustic couplers, digital communications are becoming much more reliable and are receiving widespread acceptance. This wide acceptance and familiarity are as important to the revolution in document delivery as are decreasing costs. New technologies in this area, such as light wave communication, offer continued improvement for the near future.

For libraries, the most significant change in communications in the past ten years has been the introduction of computer terminals, which use both the value-added networks and the OCLC communications network. Additional changes now occurring include the replacement of 300-baud lines with 1,200-baud as the standard dial-up communications rate. This fourfold increase in speed greatly expands the capability of dial-up terminals.

Printer Technology

Hardly any printing device now entering the market does not contain at least one microprocessor. Microprocessors are simpler, less expensive, and faster to use than the alternative — a substantial amount of custom-designed circuitry. The use of microprocessors in printer technology has had an unexpected impact on document delivery: It has become very inexpensive to add features to printers that were not available a few years ago. In particular, dot matrix printers can now supply a plotting capability at no extra cost. And, the resolution of the printers has been increased to compete with fully formed character printers (e.g., type ball and daisywheel printers). Fairly low-cost printers ($5,000) with a resolution of 100 dots/inch are becoming available now and higher resolution at these prices will be available in the near future. All of these advances further enhance printer technology for document delivery.

In the past, without this kind of printing technology, the only method of electronic document delivery possible has been facsimile transmission, where a picture of an entire page is transmitted. Libraries have experimented with facsimile transmission, but found it to be quite expensive. Now, however, it is possible to transmit text, along with formatting and typefont information, and to produce better than facsimile copy at close to the cost of straight text transmission.

To illustrate relative speeds of transmission (which are closely related to cost), consider an 8" x 8" page from a book. If digitally encoded at 300 bits per inch (facsimile), it would take 4,800 seconds (80 minutes) to transmit this page over a 1,200-baud line. (A 1,200-baud line is considered a fairly fast dial-up telephone line.) If the facsimile text was encoded and transmitted as ASCII characters, the same page would take 26 seconds to transmit, approximately 1/200th of the time. Although data compaction techniques would narrow the cost/time gap between straight text and facsimile techniques, straight text transmission remains one to two orders of magnitude faster than facsimile transmission. Higher baud rates, available on leased lines, reduce the transmission times for both techniques proportionately.

Printer technology also has affected speeds of document delivery. For high-quality document delivery, 100 dots/inch is marginal. At much higher prices ($100,000 and more) laser printers such as the Xerox 9700 can offer 300 dots/inch at high speeds. Documents from laser printers are of high quality, and we can expect that lower-priced laser models will be widely available in a few years. To illustrate just how quickly laser machines can print, the novel *Gone With the Wind* can be printed to 3 to 9 minutes, depending on formatting specifications and type size.

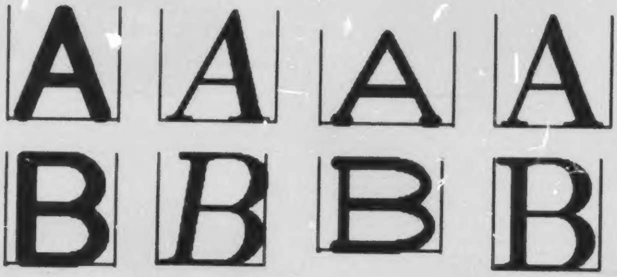
Software

The most significant impact on document delivery by far comes from software advances to the communications and printer technology. Development of software to use with the new printers has been prompted by the increasing cost of hand composition. However, while typesetting by computer has been around quite a while and, in fact, is in widespread use in the printing industry, most systems available have been relatively crude compared to good hand composition. Fortunately, one of the true geniuses involved in computer science, Donald E. Knuth at Stanford University, has spent the last two to three years tackling, and essentially solving, many of the remaining problems in computer composition of text.

Knuth is best known for his multivolume work (in progress), *The Art of Computer Programming.* In fact, the printing of this work is what prompted Knuth to develop two remarkable software systems. The economics of publishing had changed enough since the publication of the first edition of one of his volumes that his publisher was unable to produce a second edition of comparable appearance: Hand composition had become too expensive and the existing computer programs inadequate. Knuth developed two systems that would enable an author to provide formatting information for an article with little more effort than is required to type the manuscript. Yet the output would be the highest possible quality typesetting.

The first of these two systems is called TEX (pronounced "tech" as in technology). [1] TEX allows an author to lay out exactly how his paper or book will appear. Powerful macros for TEX can be constructed by experts, then used by others to do composition that approaches perfection. To illustrate, TEX collects a whole paragraph before any line breaks are made. Hyphenation, which is automatic and extremely thorough, is then done at the optimum points for best appearance. Words and lines are held together by "glue" that has a controllable stretch. TEX handles "kerning" (bringing certain letter pairs closer together than normal) and "ligatures" (substituting a single composite character for a letter-pair). Extensive facilities for typesetting mathematics are also available. A group at Stanford University is close to completing a portable version written in the programming language PASCAL. TEX itself is in the public domain.

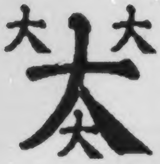
Knuth did not stop there. He developed a language system to define letter shapes. The language, called METAFONT, lets the author specify exactly the shape that characters have. If the METAFONT programs for the characters are well designed, e.g., capturing the essence of an uppercase "A," whole families of alphabets can be obtained merely by modifying a few basic parameters. Figure 1 shows four examples of uppercase letters "A" and "B," all generated from exactly the same METAFONT programs, with different parameters. An equally important result of this method of defining characters is that the same designs can then be used on a number of different output devices that have differing resolutions and yet yield essentially the same results.

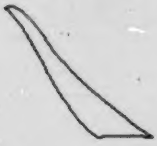


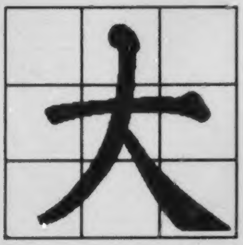
OCLC has installed on its system a version of METAFONT that allows characters to be added easily to existing fonts with some confidence that they will be in the same style as the other characters. Such a system is very important because OCLC has to cope with a great many unusual characters in bibliographic control. In the future, OCLC plans to support printing in the Cyrillic, Greek, Hebrew, and Arabic alphabets.

OCLC has experimented with some more exotic applications of METAFONT. Figure 2c shows my version of the character meaning "large." Figure 2a shows this same character with variations in size and position. This character is actually a subroutine in METAFONT that can be called to control the resulting character's position and size. This subroutine allows such characters to be used in the construction of more complex ideograms.

The sample Chinese character itself is built up from three METAFONT subroutines. Each subroutine draws a single basic stroke which together form the basic building blocks for the character. Figure 2b shows how the stroke "Ducks Beak Na" is formed. Seven points and the tangential directions of the curve were needed to define this curve. To permit control over size and placement,







the points are defined in terms of a reference point on the stroke and the overall length of the stroke. METAFONT then connects these points using a sophisticated procedure based on cubic splines. Much attention is paid to the problems of defining curves on the discrete raster available. This outline then is filled in by METAFONT to produce the resulting stroke. Although OCLC is currently only experimenting with Chinese characters, results have been quite encouraging.

Impact on Document Delivery

Both of Knuth's systems hold a number of implications for document delivery. For authors, it will be possible to see rough "proofs," even drafts of papers and books, typeset to be nearly indistinguishable from the final product, down to italics, boldface, and headings. This is especially important to mathematics authors, but is sure to be welcomed by all authors. For most efficient use, text would be transmitted and edited in machine-readable form, greatly reducing the time between acceptance of an article and the earliest it can be published in a journal.

The small publishing firm also stands to gain much. It will be able to publish materials as attractive as those from larger publishing firms and will also be able to print short runs economically. In the case of document delivery, the typical printing is a single copy; the new, high-speed printers are making this "short run" practical.

To libraries, whole realms of document delivery appear to be opening up. The American Mathematical Society is planning to start publishing its journals using TEX and METAFONT. When enough material becomes available in machine-readable, distributable form, it will become economically feasible for some centers to maintain the text on-line for electronic distribution.

In the long term, researchers might have a high resolution graphics display device for their personal use to view such articles. In the shorter term, papers printed in central facilities such as libraries will be more common. A library patron locating an article in a data base would be able to take away a copy within a minute or two, much less time than is currently needed to locate the same article in a library's stacks. How much and how soon this occurs depends on a number of factors, only one of which is technology. However, increasing dependence on electronic delivery seems inevitable, and should have a positive influence in library services.

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LENDS — An Effective Use of a COM Catalog on A University Campus

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LENDS (Library Extends Catalog Access and New Delivery Services) an active, on-going library operation at Georgia Institute of Technology since March 1972, combines remote bibliographic and physical access to the faculty. The LENDS system provides bibliographic and physical access by: (a) the placement of microfiche readers and COM catalog in each academic and research department; (b) computer and manual search services of the published technical literature; (c) a telephone request service; (d) on demand copying service for journal articles; and (e) twice-daily document delivery services.

LENDS grew out of the goal of the Georgia Tech Library to provide more efficient service to the faculty from a centralized facility on a rapidly expanding campus. In the 1960's more than a dozen new academic and research buildings placed faculty and students some distance away from the Library. From the beginning of the planning stage in 1966, the twin concepts of remote bibliographic access and document delivery were central. Our selection to participate in the MARC I pilot project spurred the remote access posibilities. When in 1968 the planning group learned of computer-output-microfilm, they immediately began to develop remote access plans around a COM produced catalog.

Proposals embodying the LENDS concept were submitted between 1968 and 1969 to the University System of Georgia, U.S. Office of Education, and the Council on Library Resources. No funding resulted. Funds were raised from the Library's budget in FY 1972 which were sufficient to begin the program in the following steps: (1) filming of the card catalog with a rotary camera; (2) production of sixty copies of a microfiche catalog (771 fiche) from this film; (3) purchase of forty-two microfiche readers and distributing them to academic and research departments; (4) development of a campus advertising campaign; (5) initiation of the delivery service; and (6) production of two COM supplements to the basic microfiche catalog.

Since 1972 LENDS has functioned as an integral part of the library operation. After a slow start, it has been completely accepted by most faculty and graduate students as the center of their library activities. Because of its delivery service, LENDS users have been able to use their time more productively and the program has been recognized by the administration of the institution as an effective promoter of faculty productivity.

LENDS is based on the availability of the complete catalog record at many campus points remote from the Library. March 1980 marked the end of a fifteen year process of converting all catalog records to machine-readable form. Beginning in 1966 all new acquisitions were cataloged according to the Library of Congress classification and a project was initiated to recatalog and reclassify all pre-1966 holdings from Dewey to LC. Because of the significance of the journal literature in science and technology, priority was given to periodicals; their reclassification was completed in the early 1970's. In 1972 the COM catalog began and steadily increased in size and completeness. The reclassification of monographs and their conversion to machine-readable form was greatly accelerated in 1975 when the library gained access to OCLC records through its affiliation with SOLINET. By 1980 the COM catalog had superseded the card catalog, and in March the card catalog was discarded and the COM version became the sole public index to the classified collection. During the entire period from 1966-1980 all new catalog records were produced in both machine readable and card form, and from 1972 in COM form as well. In other words, for almost a decade the library maintained a multiple system of producing the catalog record and produced card, film, and machine files.

When the microfiche catalog, including the first COM supplement, was created in 1972, the Library extended its bibliographic access to more than forty locations outside the library building. Over the years this number has increased significantly. Currently there are twenty-four catalogs for public use in the library and sixteen for internal library use. There are approximately sixty campus locations outside the Library and fifty outside the Institute.

The COM catalog now includes all monographic holdings. Serials are included, but only in holdings list form. The catalog is produced quarterly with a six-weeks supplement in between. Currently, five sections are produced:

Author/Title Section — (Entries are for Monographs)
Subject Session — (Entries are for Monographs)
*Call Number Order Section — (Entries are for Monographs)
Serials Section — (Entries with holdings include government document serials as sub-section)
Map Section — (Author, Title, Subject, Call Number)

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*Having the catalog arranged in call number order has increased browsability significantly since an analysis made in 1971-72 by Robert J. Greene. See Robert J. Greene "The Effectiveness of Browsing," *College and Research Libraries* 38 (1977) 314-17.

Each COM fiche has an average of 4,700 entries per fiche with entries arranged in a vertical column format. The catalog is produced at a local COM service bureau. Tapes to produce the fiche are created on CDC Cyber 70 computer in Georgia Tech's computer center. The records are stored in a unit format which is used to generate the required entries in their respective files. The data base currently contains approximately 210,000 records.

The COM fiche is produced on negative diazo or vesicular film with a machine-generated heading. Fiche are numbered consecutively within each section. The catalog is stored in clearly marked fiche panels allowing easy access to each section of the catalog. Its ready acceptance and heavy use are the best indication that it is a viable alternative to the card catalog. At the time the card catalog was discarded, not one note of protest was heard from Georgia Tech faculty or students. As far as they are concerned the COM catalog is a logical step between the card catalog and an on-line catalog.

LENDS DELIVERY SYSTEM

As stated earlier, the delivery of documents to faculty was an integral part of library planning from the time in the mid-1960's when bibliographic records began to be put in machine readable form. Remote bibliographic access, on demand service, and document delivery were the bases around which LENDS was conceived and developed. Other academic libraries including the University of Colorado,[1] Syracuse University,[2] Ohio State University,[2,3] the University of California,[3] and Brigham Young University[4] were making similar plans at about that same time. At each university library, the faculty user was highly pleased with the service and urged its continuance. These systems use library practices which have proved their worth over many years. Various academic consortia have established inter-campus delivery service between libraries and have found it most beneficial in the sharing of resources.[5] Special libraries have been delivering documents to their users at their desks for years because of the cost savings of the researcher's time that personal delivery provides.[6] Likewise, the public library has used the book-mobile for document delivery for decades.[7]

The COM catalog is the prime bibliographic source for books requested through LENDS, but the sources for journal articles are much more varied. In addition to footnote citations, colleagues' recommendations, and printed abstracting and indexing services, the faculty user has available through the Library access to most available machine-readable data bases. Library policy is to search any base to which access can be gained provided the user will reimburse direct operating charges to the library. Each reference librarian has undergone training on one or more data systems, such as Lockheed's DIALOG, System Development Corporations' ORBIT, and the Georgia Information Dissemination Center's OPIUM, and the reference staff handles all profiling and searching. Using reference librarians as opposed to technical specialists for machine searching has been highly successful.

Between 1972 and 1978, the LENDS functions were decentralized and performed in the departments responsible for each function. Coordination was handled by Administrative Services which was responsible for the delivery. Beginning in 1979, a separate LENDS unit was established which has the responsibility for all aspects of the operation. Efficiencies in responding to user requests and complaints have been the chief result; operational costs have not changed observably.

Most LENDS request come via phone, although lists of titles are also received by campus mail. In most cases the faculty requester has checked the microfiche catalog and supplies the call number for the item needed. When the attendant receives the call, he fills out a LENDS form, checks the shelf, retrieves the book, charges the book to the user, and takes the book to the mailroom for delivery. All normal circulation communications and services are a part of this operation. If the item is not owned by the Library, the user is informed, and it will be obtained for him on interlibrary loan if he requests it.

The LENDS form filled out at the time of the request has a dual purpose. First, it serves as a "status report" for the user. One copy is sent with the book when it is delivered on LENDS.

Or if the book is checked out, lost, on reserve or ready reference, or generally not available, this information is reported on the form and sent to the user. Second, the Library keeps a copy of the form for statistical purposes.

The LENDS process is accomplished fairly easily and usually with a minimum of effort and staff time. The COM catalog is effective in the LENDS system generally because the user has checked it before he calls the Library. Many bibliographic problems can be solved while the user is on the phone, since the library staff member can converse with him while both are looking at the same microfiche record. LENDS requests take first priority over any other business and are expedited as quickly as possible.

Requests for photocopies to be delivered through the LENDS system may be phoned in or submitted in writing. Often a computer printout is submitted which contains multiple requests. The staff member who takes the request prepares a LENDS form (listing user's name, department, account number to which copies are to be charged, and bibliographic information) and looks up the call number for each item. An assistant goes to the shelf, pulls each item needed, makes the photocopies, prepares them and takes them to the mail room for delivery. Again, if the item needed is not owned by the Library, the user is informed and given the option of obtaining it on interlibrary loan. If it is not located, a "not on shelf" routine is initiated and the item is sent to the user when located.

The LENDS delivery is made twice a day, mid-morning and mid-afternoon using a delivery van over an established route to the several departments. Items to be returned to the Library are also picked up at the same time.

Thus simplified, the process goes from the faculty member receiving his citation, phoning or mailing a list to the Library, the staff gathering material needed, and delivering it directly to the faculty member's department. It is interesting to note that in the past two years the Office of Computing Services and the Registrar have used the LENDS as a fast efficient daily delivery service to their user. Both offices help in financing the delivery service.

The time that elapses between phone call and document delivery varies but is usually no more than twelve hours, since LENDS requests always receive top priority by the library staff. If a user calls early in the morning, with relatively few items needed, he will have delivery that day. Even long lists to be photocopied are expedited quickly.

The recent centralized LENDS organization has improved delivery time of longer requests significantly.

USE OF LENDS

Two significant studies were made of the LENDS system during its early operation, 1972-1974.[9,10] The major conclusions reached in them remain valid and have been sustained by the experience of the past six years. (See Figures 1 and 2 for details of use). They are:

(1) The COM catalog is readily accepted and appreciated by the faculty user. Its convenient location and ease of use enhances his knowledge of library holdings.

(2) Distance from the Library is a strong determinant of use. Departments close by are low users. Distant departments are heavy users. The convenience of delivery is a great factor.

(3) The extension of bibliographic access in combination with delivery service led to a signifcant increase in total circulation to the faculty. This increase plateaued in the fourth year and has remained relatively constant since then.

(4) Greatest use is made by faculty engaged in sponsored research (Engineering Experiment Station, Aerospace Engineering, Chemical Engineering, etc.) and working on research proposals.

(5) Next in use are those academic departments in the Sciences with a strong graduate/research interest (Chemistry, Physics, Biology, etc.).

(6) Support or service departments (English, Social Sciences, Modern Languages) tend to use LENDS relatively little.

Patterns of use over the nine years have been relatively stable. Generally variations seem to be in direct relationship to the amount of sponsored research undertaken annually. During the last two years, architecture has been an exception. Use here has been high and at odds with established patterns. This may be due to the influence of new building construction and the consequent inconvenience in using the branch library in Architecture.

COST EFFECTIVENESS OF LENDS

In 1973/74 Siegmann and Citron determined a cost of $.56 per delivery transaction (includes both deliveries and returns).[10] Using the same factors, the transaction cost in 1979/80 has risen to $.90. This increase is largely due to the rapid inflation of personnel costs and greater COM production expenses because of the rapid growth in the number of entries in the COM catalog.

FY1974 Costs (adjusted to march 1980 calculations)	
Personnel	$8400
Equipment	5425
Supplies (estimated reoccurring costs)	1000
Production	
COM costs	2760
Computer cost	118
	$17,703

$$\frac{\$17{,}703}{31{,}561 \text{ transaction}} = \$.56 \text{ per transaction}$$

FY1980 Costs	
Personnel	$18987
Equipment	1915
Supplies (estimated reoccurring costs)	1000
Production	
COM costs	5179
Computer cost	1637
	$28,718

$$\frac{{}^{*}28{,}718}{31{,}998} = \$.90 \text{ per transaction}$$

LENDS has been looked upon and justified as an institutional, rather than simply a library operation. The savings in faculty time and the consequential increase in faculty productivity is significant. When the $.90 average cost per delivery is compared to the $12.00 average hourly rate of faculty whose time has been saved, the annual savings in faculty time and the consequent increase in productivity averages out to $11.10 per item delivered, or a hypothetical savings of $246,231 in FY 1980 ($.90 x 22,183 deliveries)

Average faculty salary per hour	$12.00
Average time cost of faculty member going to Library for document transaction and return to office estimated at one hour	12.00
Average cost for Library to handle LENDS transaction	.90
Savings in faculty time per document delivered	11.10

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ee Figure 1

If returning a book through LENDS is assigned .33 value of a delivery an additional $3.66 per return can be added ($3.66 x 9,805 documents returned in FY 1980 = $35,886)

Institutional Savings: Delivery	$246,231
Institutional Savings: Return	35,886
	$282,117

COST EFFECTIVENESS INTERNALLY IN THE LIBRARY

While not connected directly to the LENDS System, the availability of the COM catalog at strategic points within library work areas has led to substantial savings in internal library personnel costs because of the increase in working efficiency. The following table presents in tabular form the estimated savings equivalent to three library assistant's salaries.

Cataloging Operation	11,004
Acquisition Operation	10,008
All other Library Operations	10,008
	31,020

No effective way of measuring the time/cost relationship of users operating within the Library has been determined. Placing a dollar value on student-user time is especially difficult. The most visible evidence of satisfaction is the sharp decline in complaints. The convenience of more than 20 public access fiche catalogs (ten of which are connected to the Circulation Desk by telephone) located all over the library has reduced substantially the frustration of searching for books and determining call numbers in areas inconvenient to the card catalog and the circulation records.

SUMMARY

1. LENDS is heavily used. It has been accepted as a normal library service by the Georgia Tech faculty. It is a service which the faculty would not allow us to discontinue. Convenient and efficient services do seem to make a difference.

2. LENDS has demonstrated that a COM catalog is an effective way to display a bibliographic record. It has proved the validity of remote bibliographic access as a convenient way of bringing the user and the document together. It has indicated that reference librarians provide an effective interface between the user and the document for both manual and computer based bibliographic service.

3. LENDS is cost effective. Within the Library, savings in personnel expenses balance off the costs of operating LENDS. Substantial savings in the cost of catalog maintenance will be realized within a few years. A partial estimate of monetary benefits accruing to the institute as a result of increased faculty productivity is placed at over $275,000 annually.

4. LENDS offers a realistic and cost effective system of substituting a microfiche catalog for the traditional card catalog.

5. LENDS has strong implications as a solution to the centralization/decentralization dilemma faced by many university libraries.

FUTURE POSSIBILITIES

There are several possibilities for LENDS and the COM catalog program which have not yet been developed. Direct delivery of books to students in the dormitories has been considered but has not been implemented because of the lack of effective control at the delivery point. Any academic library which develops a COM catalog can use LENDS as a delivery service model. Several institutions in the University System of Georgia are moving in this direction. LENDS provides a real insight for future electronic delivery systems. In effect, the microfiche catalog acts as an off-line computer terminal. The user of the LENDS system should have little difficulty in making the step to information or document delivery via CRT.

Figure 1 — LENDS 1979/80 DELIVERIES

College of Architecture	2,112
College of General Science and Library Studies	6,019
College of Industrial Management	555
Engineering College	7,654
Engineering Experiment Station	4,584
Others	1,259
TOTAL	22,183

LENDS RETURN* STATISTICS

	SUMMER	FALL	WINTER	SPRING	TOTAL
1979/80	2,483	1,654	3,621	2,047	9,805

LENDS SUMMARY

	DELIVERED	RETURNED	TOTAL
1971/72[1]	1,021	1,189	2,210
1972/73	6,655	4,607	11,262
1973/74	24,956	6,605	31,561
1974/75	21,152	12,846	33,998
1975/76	26,093	7,772	33,868
1976/77	22,108	7,488	29,596
1977/78	24,875	8,788	34,105
1978/79	20,887*	9,555	30,442
1979/80	22,183	9,805	31,988
TOTAL	169,930	68,655	239,030

[1] 1971/72 statistics are for Spring Quarter 1972 *only.*

*There is an error in the total delivered for FY79 due to use o incorrect counting method for first 3 months.

Figure 2 — LENDS DELIVERY STATISTICS

	TOTAL 78/79	SUMMER 1979	FALL 1979	WINTER 1980	SPRING 1980	TOTAL 79/80
Administration	113	37	24	43	17	121
Aerospace Engineering	1595	421	502	473	330	1726
Architecture	1618	591	450	483	314	1838
Biology	871	141	236	241	153	771
Ceramic Engineering	276	46	51	90	32	219
Chemical Engineering	996	349	223	412	120	1104
Chemistry	2289	712	431	826	419	2388
City Planning	290	78	62	51	83	274
Civil Engineering	753	216	97	301	154	768
Electrical Engineering	338	73	58	77	91	299
Engineering Experiment Station	4066	1846	897	1212	629	4584
Engineering Science & Mechanics	835	231	217	297	192	937
English	254	74	86	66	45	271
Geophysical Sciences	402	79	81	146	112	418
Health Systems Research Center	118	51	34	49	16	150
Industrial & System Engineering	626	211	145	177	118	651
Industrial Management	478	160	100	184	111	555

	TOTAL 78/79	SUMMER 1979	FALL 1979	WINTER 1980	SPRING 1980	TOTAL 79/80
Information & Computer Science	530	299	130	116	51	596
Mathematics	281	55	80	69	57	261
Mechanical Engineering	833	243	182	276	152	853
Modern Languages	125	16	34	21	46	117
Nuclear Engineering	419	200	67	182	41	490
Office of Interdisciplinary Programs	99	27	10	21	18	76
Physics	788	247	202	229	213	891
Psychology	566	129	141	158	70	498
Social Science	334	138	120	97	49	404
Southern Technical Institute	90	22	30	24	21	97
Textile Engineering	571	120	137	121	79	457
Others	333	99	78	119	73	369
Total	20887	6911	4905	6561	3806	22183

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Opening A New Catalog — The New York Experience

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The advent of a new set of cataloging rules in January 1981 has stimulated much discussion about and interest in alternatives to the card catalog among academic and research librarians. In that discussion, principal attention has been focused on on-line or microformat catalogs, or some combination of both. This paper reports on the methods used in one research library to convert a large card catalog to both computer and microformat, and on experience with the use of these new catalogs.

By way of background, the New York State Library is a large research library, with a collection of sufficient size and scope to qualify for membership in the Association of Research Libraries, and with a public catalog of 3.2 million entries. Although we circulate about 400,000 items a year, most of our borrowers never come to the Library — the two largest groups of users access our collections through interlibrary loan or are mail order customers of our Library for the Blind and Visually Handicapped. This makes us especially sensitive to the costs of using the catalog — the high volume of staff use is a direct cost to the Library, and problems of accessing catalog information are not passed on to a group of other users. Our largest group of on-site users, however, is a very demanding one. They are Legislative and State government users, and they generally need quick access to information on a wide range of often esoteric subjects.

The decision to develop a computer-based catalog at the State Library was made as early as 1970. We stopped adding cards to our public card catalog in March 1975; we stopped using the card catalog in April 1978 when we moved to a new building and left the card catalog behind. The initial decision to begin a new catalog was not related to any concern about the bibliographic content of the catalog. It was based on the opportunity of utilizing new technology to control costs and to improve the effectiveness of catalog use. In short, we were interested in breaking out of some of the limitations the physical format of a card catalog imposes.

In 1970, we were planning to move to a new building, providing us with the opportunity to consider new approaches to bibliographic access which would make full use of new technology and be appropriate to the changing mission of the Library. The physical environment of a multi-floored new building made a single, central card file an inappropriate planning option, and the major capital investment in card catalog cabinets, floor space, and the moving of the card file itself helped make new technology a viable economic choice. Computer technology offered a catalog with enhanced search capabilities, allowing the use of Boolean operators for subject searches, for example. We could forecast savings in staff time in maintaining the card catalog (in 1972, we were spending $41,000 a year just to file cards).

We also anticipated savings through decentralized access to a single centralized file. The successful completion in 1970 of our automated serials system underscored the value of an integrated records system, and made us realize how much of the way our work was organized had been dictated by the physical locations of card files. A computer-based file offered the opportunity of easy replication, decentralized access to a single record, and a variety of output formats.

Our plan for closing and replacing the card catalog had three components. The first involved the creation of a computer-output microfiche for current catalog information. This fiche is produced from OCLC tapes (representing State Library cataloging since 1974), using format and authority file programs at The New York Public Library to produce a dictionary catalog in COM format. The catalog cumulates semi-annually, with biweekly supplements. Development of this component allowed us to stop filing catalog cards in 1975.

The second component consists of a microfiche file, produced by filming our public card catalog. This nine-month project was accomplished through an outside vendor, using a microfilm camera controlled by a mini-computer. As a result, our 3.2 million public card catalog is now available on 1620 microfiche, at a production cost of a little over .02 per catalog card. The master film was produced to archival standards, with a specified high standard of resolution (132 lines per millimeter with perfect horizontal/vertical alignment). The production of this microfiche file allowed us to move to our new building in 1978 without a card catalog.

The third component is a machine readable data base containing a retrospective conversion of our library shelflist. This machine readable file consists of short entries, each containing a record identification number, a library call number, author/ title/ subject information, Library of Congress card number, holdings, and accession number. The project was carried out by a local computer service agency (one with some experience and a great deal of interest in library projects). Bid specifications for this project were carefully drawn (over 12 pages of text), with very closely defined quality controls. Records were sight-tagged by the vendor. Library staff evaluated the quality of each record batch on the basis of a daily random sample of records. Performance standards were set on a field-by-field basis, with the vendor required to provide 100% accuracy in such fields as control number and call number, and 99.5% accuracy in fields involving search keys. Since the vendor was required to re-key the entire batch when the random sample failed to meet the standard, there was a high motivation to insure the accuracy of initial input. State Library staff were responsible for inputting complex holdings (pre-defined) in an on-line mode, utilizing a file made available by the vendor. The project converted 650,000 records in ten months and required a staff of 16 at the State Library and 16 to 25 at the vendor's site. The cost was .47 per record.

This file is currently available to users in an on-line mode, providing access to bibliographic records by author, title, and call number. Our catalog consists of two major components: the on-line file with author, title, and call number access, and the microfiche file providing full bibliographic information and subject access. The latter is also useful for locations where it is not cost-beneficial to have on-line terminals.

We have now had two years of experience with the microcatalog and about one and a half years of experience with the on-line catalog. Reactions of users have been mixed: most accept the new format, some are enthusiastic, some are disappointed or critical. A study of user reaction to the microcatalog conducted last year indicates that 68% found it "convenient" or "very convenient" to use, and that 45% preferred it to the card catalog (23% were undecided, and 32% preferred the card catalog). In a much more preliminary and limited study done this summer of on-line catalog users, 65% described it as "effective" and 35% described it as "very effective." In the first months, we found that the need for staff intervention was high — nearly every user had to be instructed in catalog use. This staff intervention is not necessarily bad, though, since most catalog use studies show that the complex organization of large catalogs causes many library users to fail to find material the library owns. There is definitely an overall savings in staff time: a 3.2 million card file at an employee's desk makes for faster and more productive searching.

The State Library's computer-based catalog is also a potential major component of a statewide electronic locator file which will facilitate resource sharing. Current and retrospective conversion projects such as that of the State University of New York, the State Library HEA Title II-C project (which is adding selected subject holdings from six major university libraries to the OCLC data base), the MILCS (Metropolitan Interlibrary Cooperative System) project in the New York City area, and the participation of Columbia, New York Public and other libraries in RLIN are building a valuable electronic file of information about holdings of libraries in New York State — a file currently estimated at over five million bibliographic records. This information presently resides in a variety of locations including OCLC in Ohio, RLIN in California, and several places in New York State. The next challenge is to design and develop the mechanisms which will connect these locator files and which will insure that the benefits of these new tools for resource sharing will be equally available to all the libraries and library users of the state.

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The Developing Nationwide Network of Library and Information Services

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A nationwide library and information service network will not be a monolithic superstructure controlled at the Federal level. The present multiplicity of networks at the state, multistate, and national level make it impractical and virtually impossible to develop, organize and govern, a single nationwide network. Our pluralistic philosophy calls for coordination, cooperation, and sharing — not forced merger and domination. The technology also supports a continuation of the present pluralistic development. The price and capability of minicomputers, the development of video disc, and telecommunications advances all tend to strengthen local options. However, there isn't any doubt that even with today's information revolution, self-sufficiency for libraries and information centers is not a realistic goal. Sharing of resources, both human and material, is essential if we are to meet the needs of our users. To do so effectively and efficiently will require cooperation and coordination between libraries and information centers at all levels — local, state, multistate and national. We already have a nationwide network of sorts — it is made up of many existing independent organizations; it is not coordinated overall, but it is successfully and effectively managed in many of its parts, such as OCLC or the National Library of Medicine's Regional Medical Library Network.

To understand this national library and information service network, you must look at its development hierarchically. Many states have at least one statewide network activity which is generally public library oriented and coordinated and administered by a legally established state library agency. In most states this official state agency, in addition to its responsibilities for public library services, also has the authority for coordinating academic, special and school library services. It also administers the funds for any of the Federal Library grant programs. Illinois, Minnesota, and New York are three examples of states with well-developed networking activity. In Illinois, there is a statewide network (ILLINET) established by law which provides for regional library systems. Although initially limited to public libraries, the network later was expanded by regulation and practice to include all academic, special and school libraries. Through the statewide system, resource sharing occurs by reciprocal library cards or interlibrary loans. A number of the regional library systems have installed automated circulation systems (mainly CLSI) which are also serving as automated interlibrary loan sub-system between library systems. In addition, any type of library may participate — through the state library agency — in OCLC. The state library agency, unlike the non-governmental cooperative regional organizations, absorbs all the costs incurred in the administration of the OCLC program.

To assure the successful operation of the statewide network, the state library agency provides staff to coordinate and provide the training necessary for libraries to become OCLC users and to adopt AACR II. They also encouraged the adoption of standards for CLSI interface. The state supports all of the administrative costs for consulting services and provides the funds to support the interlibrary loan costs for all libraries who are members or affiliate members of the regional systems and who use the state's research and reference libraries. Four libraries (two public academic, one public and one state library) serve as basic resource centers with four other libraries (two private academic and two private not-for-profit libraries) serving as special collection resource centers. The State Library Agency also funds the regional library systems for staff, collecting, consulting services, etc. All residents of the state have free access to the services provided by the statewide network through their local library provided they are a member of one of the regional systems.

In Minnesota there is a network organization called Minitex, in which academic, public and special libraries may participate. It is basically supported by state funds. It receives additional funding from two sources — Federal funds provided by grants through the Minnesota Office of Public Libraries and Interlibrary Cooperation and funds from participating members fees. One major service provided by Minitex is journal access, for which the user satisfaction success rate is almost 90 percent. Minnesota does have some regional public library systems but full statewide coverage is not yet a reality.

New York has twenty-two statewide regional public library systems developed and funded by the State through the state library agency. The agency also provides opportunities for special, academic and public libraries through its Reference and Research Library Resources Program (3R's) with nine regional systems. The state library agency also offers a statewide interlibrary loan network through NYSILL (new York State Interlibrary Loan Network) which is available to public, academic or special libraries through the regional public library systems or the 3R's. Academic libraries have the opportunity to participate in OCLC through the State University of New York — SUNY/OCLC Network.

The three state samples describe networks that are voluntary, and essentially hierarchical, and which provide funds for statewide net lenders (i.e., libraries which lend more than they borrow), offer the local library the opportunity to participate in OCLC, provide training opportunities in a variety of areas such as OCLC, AACR II, use of on-line data bases, etc., and also provide the mechanism to develop common procedures and standards. Most importantly, the statewide network provides the users of the participating libraries with access to the full range of resources available from university, college, public and special libraries. Resource sharing in these states is a reality; although it's not perfect and is often slow, it is effective. Energy and concentration can be centered on improving the networks rather than on the organization problems and fears associated with establishing a statewide network. These three states have had experience in dealing with problems of maintaining autonomy, sharing resources, agreeing on procedures and standards, and drafting, lobbying and passing legislation.

In two of the cases (Illinois and New York) the state provides the bulk of the funds for the statewide network. Local funding is used for the basic support of the local library. The local library plays its rightful role by providing services designed to meet the immediate needs of its own user clientele. It is this system of shared funding responsibility that will make a nationwide library and information service network financially possible and fiscally responsible. The local library, as a participant in a regional (within the state) and state system, has immediate, free, or low, cost access to the full resources of the information and knowledge-rich academic institutions. Through the system, they also have access to national collections. However, if these three states participate in multistate or national resource sharing, they do so only after all reasonable means for satisfying a user's request for any given book or journal were first exhausted within the state. It is this assurance that will help balance resource sharing at the national level and avoid over-reliance or misuse of our major national institutions.

What are some of the major problems in trying to replicate, at least to some degree, these state networks in other states? Are there services which can more effectively be provided on a state basis? On a multistate basis? Which services can be more effectively and efficiently administered and provided on a national basis? Currently, there is general agreement that cataloging services can be most effectively and efficiently provided on a national basis through a "utility" such as OCLC or RLIN or on a regional basis through the Washington Library Network (WLN). For many states an intermediary or service center such as NELINET, SOLINET, MIDLNET, BCR or Amigos can be most effective. They offer libraries in a multistate area access to OCLC, provide training, data base services, etc. A number of states do not have the resource capability — financial, material or staff — to justify a state system such as those in Illinois and New York. The multistate service centers are cost and service effective and can most effictively serve these states.

A true national system will be multi-level. In states that have large populations and are rich in resources, a local-state-national network pattern seems appropriate. Within the state there may be some regionalism, especially in urban areas. Funding of the networks in these cases is primarily from the state with some funds from participant's fees. In states that have sparse populations, geographically remote areas, and limited resources, a local-state-multistate-national network pattern appears to be more appropriate. For these states Amigos, BCR, NELINET, SOLINET, etc., play a vital role in coordinating within the multistate area as well as providing the bridges between states and national agencies and institutions. Funding in these cases is varied — members' fees and contracts with state agencies provide the base.

The issue of governance is one that needs to be addressed in depth and a consensus should be developed. As mentioned, a nationwide library and information service network will not be a monolithic superstructure controlled at the Federal level. Governance in a pluralistic society must be a shared responsibility. The governance structure must be reflective of its parts. It needs to be democratic but have enough authority to be effective. The problems of control, representation, and assuring effective and continuing communications are some of the major issues that must be resolved. In 1978 the National Commission on Libraries and Information Science and the School of Library and Information Science, University of Pittsburgh, sponsored a conference on the structure and governance of library networks. Many excellent suggestions were put forth in the proceedings of that conference. More recently the Library of Congress' Network Advisory Committee devoted its full meeting to a discussion of network governance. Some of the issues discussed were: Is governance necessary? What are the barriers to governance? Who are the stakeholders? What effect will technology and electronic communications have on governance? Under what terms would governance be acceptable or non-acceptable?

The major problems to be solved if we are to truly develop a nationwide network of library and information services are not structural, technical, or even financial — they are human. We all operate out of defensiveness and fear. We want to protect our turf; we over-worry about our primary clientele — usually not to their benefit. We are not willing to take chances, experiment, make decisions, run the risk of losing our popularity. It's not really clear if librarians and information specialists truly believe in cooperating and sharing. We don't want to become dependent; we still long for basic self-sufficiency even though we know it is financially and physically impossible. Many of us dislike planning, while others continually plan, but are afraid to act. We have all learned to some degree how to succeed, but most of us don't know how to cope with failure and it frightens us. As a result, we move very carefully, slowly and not always effectively.

We are fearful of control either by the government or by some organization or agency. Once "hooked" it is difficult to get away. We must learn as B.F. Skinner has said that the "distinction is not between liberty and control but between feeling free and feeling controlled, between activity to avoid something — negative reinforcement — and acting to gain something — positive reinforcement." But then, these are all human traits. Our overriding problem is how to cope with the complexity of today's society and its information overload. The solution is really easier than it appears. We must develop a true understanding of sharing — of working together as a group and not as individuals. We need not submerge our ideas or personality, but share them for the benefit of all of society not just for the benefit of our local institution or our primary clientele. Librarianship is a profession that exists to serve people. Service, not process, is the goal. Libraries, after all, must not only provide information to people and support their work-related responsibilities, but help people by providing collections and services that will stimulate their imagination and dreams, thus contributing to a happy and fulfilling life — as well as a useful life.

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[1] The Structure and Governance of Library Networks, ed. by Allen Kent and Thomas Galvin. New York, Marcel Dekker, Inc., 1979.

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Bibliographic Service Development Program: A Stimulant for Cooperative Effort

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The Bibliographic Service Development Program, or BSDP a Council program funded by seven private foundations and NEH, has been in existence for nearly two years. The backgrounds of the program and its rationale have been well documented in the literature.[1,2]

At the two-year mark of this five-year effort, projects are underway in four major program areas: (1) standards, both bibliographic and technical, (2) linking bibliographic databases, (3) authority systems, and (4) services and products from bibliographic databases for library users. These interest areas have been developed with the assistance of a Program Committee composed of the chief executive officers of the U.S. bibliographic utilities, that is OCLC, RLIN and WLN plus Henriette Avram of the Libary of Congress, Carol Ishimoto of Harvard and James Govan of the University of North Carolina at Chapel Hill.

Actually, the term "utility" is a source of some irritation among the institutions most commonly referred to by that term. In fact, their joint opposition to this terminology sometimes seems their strongest point of agreement. When the term is used in this paper it is an abbreviation of the phrase "bibliographic utility" and is defined as in LC's *Network Planning Paper #2: A Glossary for Networking* as, "an organization that maintains on-line bibliographic databases, enabling it to offer computer-based support to any interested user . . ." LC itself is clearly not a utility, though it may someday choose to act like one. OCLC, Inc., the Research Libraries Group's (RLG) bibliographic support system — The Research Libraries Information Network (RLIN) — and the Washington Library Network (WLN) all qualify under this definition as bibliographic utilities.

Following is a thumbnail sketch of the major projects that have been completed or are underway in each of the major areas of BSDP interest.

First, standards. We believe that the development, adoption and use of standards, both technical and bibliographic, will help destroy barriers to cooperation among bibliographic utilities and other sources of bibliographic records. An example of this is a Joint Committee on Biblioghraphic Standards which was appointed last year by CLR to help assure that when LC selects options in the new cataloging code (AACR-2) the bibliographic utilities have and take the opportunity to review them and offer suggestions to LC. Standards under development in cooperation with the American National Standards Institute Committee Z39 include: (1) an institution identification code, (2) a code for recording detailed holdings in bibliographic records, and (3) an application level protocol for communication of bibliographic data between computers.

The second area of BSDP interest is the linking of bibliographic databases. Clearly, if library users are going to have access to bibliographic information about all or a large part of the rich resources available in U.S. libraries, some link mechanism must utlimately exist. The link need not necessarily be between utilities, it may be a link in which the user switches himself from source to source using a terminal. Link projects supported by BSDP funds include a study by Battelle-Columbus Laboratories on service and economic impacts of linking the bibliographic utilities, and a cooperative effort involving WLN, RLG and the Library of Congress to link their authority control systems.

The mention of authority control brings us to the third area of activity which is based upon the assumption that an authority controlled database enhances the quality and consistency of retrieved information. The cooperative project between WLN/RLG/LC involves more than linking authority systems. It also includes support for enhancements to the WLN and the RLG authority control systems. Another related project involves all of the utilities in a Task Force on a Name Authority File Service, the intent of which is to produce a name authority file, built by contributions from several institutions, with quality control at the Library of Congress and available to any library that chooses to use it.

The fourth area of BSDP interest and activity is the provison of products and services from bibliographic databases to library users. RLG and OCLC undertook a joint effort to assess the state of the art in on-line public access catalogs and produced a report which will soon be released. CLR is evaluating several proposals that relate to on-line catalogs including assessment of how library users adapt to them.

CLR's history is marked by efforts to help the academic and research library community resolve their most pressing problems — often by providing modest amounts of risk capital or arranging for meetings to help focus analytical attention on identified problem areas. The BSDP continues this spirit of simulating mutual effort to address possible solutions to problems.

While cooperative effort characterizes the basic approach, a corollary assumption is that projects must take advantage of existing institutions and their strengths. In the first months of the BSDP program, initiatives were concentrated with the existing U.S. utilities and the Library of Congress— organizations which appear to have the greatest influence in bibliographic matters. The initial projects of the BSDP reflect the nature of problems faced by the utilities. Each project takes advantage of resources contributed in one way or another by the utilities and has, as at least one objective, reduction of duplicate effort.

Earlier we used a common definition to describe the bibliographic utilities, but as we begin to work with them, we find that commonality limiting. One of the more frequent mistakes by authors writing about the utilities, is to ascribe an identity among them which does not exist. OCLC is by far the largest of the three U.S. utilities, organized under the laws of Ohio as a not for profit corporation. It provides shared cataloging and other services to over 2,000 libraries and seeks to serve the needs of any kind or size of library in any state of the Union, in Mexico, Canada and soon Western Europe. OCLC serves some libraries directly, but for the most part relies upon regional networks to market, train and promote OCLC services. OCLC libraries have formed various types of user groups in efforts to encourage OCLC to better serve specially perceived needs.

WLN is a regional utility, confining its market area to the Pacific Northwest including Alaska and the western provinces of Canada. This utility functions more like a cooperative with members helping shape the development of additional services. WLN is similar to the OCLC regional networks in terms of size and geographic limits, but it also has programs that are not necessarily related to its bibliographic support services. All types and sizes of libraries are encouraged to join and to take advantage of WLN services. The WLN software is the only WLN product marketed outside the Pacific Northwest with replications going on in Australia, SOLINET and the University of Illinois.

RLG, on the other hand, is a "program driven" organization. Those programs include shared access to materials, collection management and development, preservation of materials and provision of bibliographic support. The bibliographic support system, RLIN, provides support for many of the RLG program objectives. The objectives and activities of RLG are determined by the owner/members of the corporation. RLG operates without geographic limits, but since it attempts to serve the needs of the research library community, it does have a "type-of-library" constraint.

To underscore my point, these are not identical institutions. They are doing many of the same tasks and providing similar services, but their goals and objectives are dissimilar. There was a period when one could accurately describe the relations among them as competitive — even antagonistic. That appears to be passing. Tenuous lines of communication are being established. Operating staff of the utilities have been meeting and talking for years. In organizations such as NAC (Network Advisory Committee) and the BSDP Program Committee, the chief executive officers of the utilities have been meeting for several years as well. Recently, senior utility officers, their advisors and members of their governing boards announced that they had met and planned to meet again. Continued discussions will begin to resolve human and political barriers to more productive cooperative activities.

Each utility has achieved or is close to achieving a stable operating base with sufficient income to finance new plant equipment and services as needed. The market is not yet saturated so there is room for growth. We have a reasonable idea of who the principal organizations are or will be in the nationwide networking of bibliographic services.

There is an entire infrastructure that has only been mentioned in passing — the regional networks, some state-wide, some multi-state, principally serving as brokers for OCLC services. Some have signed "search only" contracts with RLG and one, SOLINET, has purchased the WLN software with the intent to offer services not presently available from OCLC like subject search and authority control. Should it succeed in this effort, it would not be surprising to see other regional networks follow a similar path.

There is much activity among the regionals which are searching for an appropriate role beyond that of OCLC broker. But, there are a host of questions that relate to these networks. Would libraries be better served dealing with OCLC individually? Are there legitimate roles for these networks? If so, are they roles more efficiently filled by them than other organizations? How large of small must the support base of a network be? It all boils down to carving up the library service pie. So far the answers are not clear. Indeed, we may not yet realize what the important questions are.

The BSDP role in all of this is a catalytic one. Meetings to discuss issues and options lead to activity quite apart from BSDP sponsored activities. Efforts to pull people together to work on small issues leads to the discussion of much larger ones. Occasionally, we see progress made by two or more organizations. Slowly, as the most pressing technological and bibliographic issues are solved, the community moves forward toward that first plateau goal — a nationwide bibliographic network for libraries but, more importantly, for library users.

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International Resource Sharing

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Throughout the world, library-based information is being recognized as a crucial international resource which has a key part to play not only in industrial, scientific and technological development, but also in the diagnosis and solution of social problems and in improving the quality of life. Significant efforts are being made to make library-based information available irrespective of geographical and political boundaries. This paper is an attempt to reflect the increasing demand for information throughout the world, to describe the expansion of international interlending, to cite several models for international interlending, and to describe some acquisitions and preservations projects based at The Center for Research Libraries as illustrations of international resource sharing activities that enable library-based information materials of one country to be available to libraries in many countries. Finaly, there is a brief discussion of contributions local libraries can make to international resource sharing.

Library networking is progressing at a rapid pace at the international level. The recent acquisition of the Washington Library Network Software by Australian libraries is one current example. The European library community members are turning their attention to technology as a way to solve some of the problems that face their libraries. In many instances, their problems are similar to problems facing American libraries: too many materials, too few funds, and to little preservation of existing collections. As one examines the emerging countries of the Third World, it is apparent that they are placing great importance on library-based information. Many of these nations are building entire political, social, and economic systems from the ground up. While libraries must compete with all other facets of a society for adequate resources, some governments realize that library-based information is essential to identifying the alternatives available and making the correct choice among them for the development of their country.

International resource sharing can be seen in the role of the wealthier nations in this global development process. Many of the wealthier nations face the dual problem of an abundance of resources with an accompanying shortage of funds. Yet, they do have the experience to organize systems to meet local need as a way to establish effective models not only to improve their own library-based programs but to serve as patterns for other nations. At the International Federation of Library Associations and Institutions, a Netherlands based organization dedicated to libraries, several major programs have emerged in recent years as a focal point for the attention of the Association's membership. One program, Universal Bibliographic Control or UBC has as its task to estabish a systematic and consistent approach to bibliographic control throughout the world. Another program, International MARC, is attempting to develop a standard bibliographic language for libraries of all nations. The program of most interest to international resource sharing is the Universal Availability of Publications Program or UAP. The concentration of this paper is this program and its international interlending aspects.

The IFLA Office of Interlending estimates that the extent of international interlending is now between 800,000 and 1,200,000 transactions per year. Great Britain, for example, sends abroad more than four times what it did twenty years ago. This certainly illustrates the need for a systemaic program of international resource sharing. Yet, the subjective satisfaction rate, that is, the rate of which the borrower or requester receives what he or she seeks, must be improved dramatically for international interlending to expand. Systems for identifying who holds the materials required are proliferating. Yet, we must be aware that availability tends to increase demand while unavailability tends to decrease demand. For the past decade some 15 interlibrary loan institutions, mostly in the United States and Western Europe, have furnished more than 75% of the total demand largely as a result of better knowledge about the availability of those materials.

There are several factors to consider for successful international interlending. First, a designated center must have the ability to provide the service. If it is unable to acquire the materials and to staff its function appropriately, it will fail. Second, such a center must acquire and maintain the necessary location tools of its own collection as well as those of surrounding institutions. Third, it must have in-house an adequate supply of materials. Otherwise, significant time is lost in going from place to place to try to obtain the requestor's needs. Fourth, it must have efficient procedures. Such procedures are imperative to insure a high satisfaction rate, which, along with cost, is a key consideration for international interlending.

Another consideration is the ease of use of the interlending center. One must consider its ability to monitor demand as well as the political stability of the nation in which it resides. The international interlending center must be capable of expanding and retracting to meet seasonal highs and lows as well as occasional changes in demand. It must operate with optimal efficiency and select its book stock and journal stock so as not to have too great a collection that is never used and yet avoid not having enough to satisfy normal demand. The international interlending center must be based on economic soundness and have the resources to operate effectively. A final consideration is that such a center must instill in its borrowers a sense of exhaustiveness so that they believe that when an item is not readily available through the interloan center, it also could not easily be obtained by requesting it directly from the other institutions within the area of responsibility of the interloan center.

Examining these key considerations leads us to several models that might be appropriate. The first is a worldwide center to which all international interlending requests would go. One needs only to read the morning newspaper to understand quickly and clearly that such a center could not function well at all. The hot spots and troublesome aspects of international diplomacy would surely interefere with the operations of this type of center. A second model is a worldwide cooperative or series of linked-together interloan centers appropriately placed throughout the world to provide optimal service to the world's needs for international resource sharing. Since 15 such centers are not providing more than 3/4 of the need at present, this model clearly holds a promise of success. The present configuration is limited in that many areas of the world are not appropriately covered. It will require some organization such as the united nations (UNESCO) to see that nodes in such a cooperative are established in other parts of the world.

The astute reader may be quick to ask how this is relevant to a university in the United States. Very few major universities have no international area studies activities at this time. We are a global society, inextricably linked to happenings in many other parts of the world. Area studies were begun in many cases with PL 480, a federally funded program that used World War II loan repayments to the United States in local currency to purchase local research and library materials for deposit to American libraries. Some of these programs have since ceased to operate under local currency and have been replaced with dollar-based programs. Yet today's participants in the India program are faced with the imminent demise of the rupee-based program in that country. This is clearly relevant to our need for a sound and systematic international resource sharing program.

Over the last decade, The Center for Research Libraries, a Chicago-based cooperative of research libraries in North America, has established several microform projects to acquire and preserve materials in various areas of the country. Handling these materials is over and above the normal activities of both the Center and its member libraries, and helps to make area studies materials available to may libraries in many countries.

A further example of international cooperation through the Center for Research Libraries is its Journal Access Service program with the British Library Lending Division. The British service has grown over the last decade to be a highly successful national periodical center, expanding a handful of requests some 10 years ago to more than 2 and 1/2 million requests in more than 60 countries today. The British have clearly constructed a model which is working well. Some of its success is attributable to the particular geography and communication capabilities within Great Britian, but much is due to the staff at the British Library Lending Division for their efforts in building a functional activity that is cost effective for many users. CRL has open discussions with BLLD to explore cooperative acquisitions for national lending library systems for both countries. While these discussions are extremely preliminary at this stage, they do point to a promising future for international resource sharing.

To begin moving to fulfill its stated commitment to international resource sharing and to improve progress toward the achievement of its mission to its member institutions, The Center for Research Libraries' Board of Directors recently established five new priority development goals. These goals are part of the Center's five year strategic plan to be clarified and presented to the library community in the United States and Canada in the coming year. The first strategic planning goal (priority) is to develop improved access to CRL collections. The initial phase of this effort will involve planning bibliographic access. Once the plan is developed, the various alternatives will be evaluated, resulting in an implementation statement for realizing this objective. Some members of CRL have stated they would like to see the CRL collection be represented as if it were a branch or departmental library of their own institution, thus giving them ready and available knowledge of what the CRL collections contain. It is clear that this is increasingly important to the acquisitions decisions made in the CRL member institutions as their funds become increasingly less able to cover all of the requirements levied by their users.

The second priority is to improve CRL's administrative processes including the areas of public relations, publications, and accounting and budgeting systems. This may not appear to be directly related to international resource sharing, but the resultant optimal efficiency, economic soundness, and ability to monitor demand as well as maintenance of efficient procedures are clearly part of an international interlending and resource sharing commitment.

For more than 25 years, CRL has been discussing the need for expanded and improved facilities for housing its collections and staff. Last spring, the Council (membership) of CRL voted to direct the Board of Directors to embark upon a building program. This is now the third priority activity set by the Board. Currently, a program statement for that building is underway and it is expected that new facilities will be available within a reasonable period of time.

As mentioned above, dollars are growing increasingly more difficult for libraries to acquire and each dollar seems to stretch a shorter distance in obtaining and housing the materials that are so sorely needed by CRL members. For over three decades, CRL has been collecting, through purchase and deposit by member libraries, infrequently used materials which are supplemental collections to its member's holdings. This activity has developed on an incremental basis, often without a serious examination of the long term potential. The Board of Directors has established as its fourth priority a project to examine thoroughly the acquisitions policy now in effect and, in recognition of the international commitment that CRL has, to suggest improvements in that policy. It must be noted that many CRL members have been making acquisitions decisions for their own collections based on what CRL has been collecting. The Board of

Directors is committed to the policy of refraining from capricious or precipitous changes in the acquisitions program so as to hinder the benefits of the CRL collection to cost saving techniques at member institutions.

Last, but certainly not least, CRL's Board of Directors has recognized its members' demands for a national periodical lending system. This would include not only the less frequently used materials but the more frequently used as well. Current planning, with the assistance of other vitally interested organizations, revolves around the development on an incremental basis of a national periodical lending service. The exact details of this are to be worked out over the coming year. While the immediate need is certainly there, this is such an important undertaking that it cannot be rushed into without adequate analysis of the alternatives. Numerous studies providing mountains of data have already been done and a close evaluation on the brink of implementation also should be done.

This set of priority projects, activities, and tasks is oriented toward improving the ability of CRL to meet its commitments to its members and to other users throughout the world. Certainly there are many problems to be resolved, one of which is the source of funding to provide for this expanded program. Some members, however, have indicated that without CRL movement into these areas, the cause of research libraries may be lost indefinitely.

There are several contributions that local libraries of any type and size can make to foster international resource sharing. There are a variety of models evolving for resource sharing through networking, through interlending, and through national information policy development. These models involve local libraries, and they must be tested. Local libraries must remain current and aware of the new developments in international resource sharing. Cooperative activities are expanding, and it is clear that some libraries are beginning to base managerial decisions on the extent of their involvement in cooperative activities among libraries. Many cooperative activities related to the shared use of cataloging records and to the physical delivery of materials in small geographic areas, or in interconnected circulation files are expanding from the local level to the international level. The willingness of the local library to participate in these programs at all levels to the fullest extent possible will have a profound impact on the expansion of resource sharing strategies from the lowest to the highest levels. This is the greatest contribution the local library can make: involved and active participation in resource sharing among all types and sizes of libraries. The availability of funds and the increasing demands of the users of libraries in the future requires more astute planning, communication, and control of cooperative activities.

ROLE OF TECHNOLOGY: TWO VIEWS

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The Role of Technology in Colleges and Universities

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Any major research university plays a significant role in expanding the boundaries of knowledge. When new knowledge is applied to developing technlogies, the synergy created can level barriers between disciplines or extend the frontiers of knowledge further still. The role of technology in colleges and universities, in this general sense, is virtually the role of technology in our society. This paper is not quite so broad in scope; rather, it is confined to the tecnologies associated with computing and telecommunications, and their applications to the administration and management of institutions of higher education.

INTRODUCTION

The often discussed issues of enrollments, inflation, energy, collective bargaining, tax resource constraints, increased accountability, and decreasing purchasing power will continue to dominate the discussions of higher education administrators in this decade. These concerns are, generally speaking, problems for managers more than for educators, although the two are not mutually exclusive. They are quite different than the issues of the 1960's or 1970's when access and growth, programs and new campuses were foremost in our minds and in our time for planning and review.

These problem areas will require a great number of imaginative and innovative responses if the quality of our universities is to be sustained during these next few years. Some form of technological improvement is likely to be part of a solution to the problem.

In a discussion of the management of information systems, the subject of this paper, the technology is largely a combination of computing capability, communication networks, and systems. The management issue is that of planning, organizing, and bringing to life the resources to accomplish certain objectives. The management task is administrative in nature and can be improved through the technology we often call data processing.

Computing and telecommunication technology apply successfully to two major areas of current administrative concern: administrative productivity and resource sharing. In the world of shrinking availability of resources, increased productivity and shared, rather than proprietary or duplicative, resources have immense appeal. Following are some examples of technology with proven effectiveness in each of these areas, as well as the author's judgments on how and which other technologies will be effective.

ADMINISTRATIVE PRODUCTIVITY

The following data demonstrate the contribution of computer and communication technology to increased administrative productivity. These data reflect activity at the University of Illinois in the last few years, and should be introduced by a word or two about data processing at that institution.

The University of Illinois has established a large data processing organization across the entire University: the University Office of Administrative Information Systems and Services (AISS), with 311 FTE in 1979. The complexity of this organization is due primarily to the need to accommodate not only a multi-campus university, but also to respond to the objective of a single university-wide plan with certain university-wide as well as unique campus needs.

Total expenditures for administrative date processing for FY79 were $9.429 million or about 1.6% of the total University operating budget of $570.8 million. The components were:

Salaries & Wages	$5.040	53.5%
Hardware & Software	3.131	33.2%
Supplies & other	1.258	13.3%
	$9.429	100.0%

In order to demonstrate improved administrative productivity, historical data are necessary; but so many complicated measures and arguments on this subject are available, that one may argue on this subject as one chooses. For this paper the issues will be viewed in a global, "bottom line" way. The total Administrative and General budget is a percent of the total budget. When A&G goes down as a percentage, the reduction means better productivity, assuming of course, that the quality remains constant.

The University of Illinois began its major expansion in data processing about 1972. 1971 was the last base year when ADP was a local, campus-based, rather traditional activity. In FY71, the total budget of the University was $311,184,711. The A&G budget was $23,700,052 or 7.62% of the total. ADP was a budget of $4,862,000 or 1.56% of the total and 20.5% of A&G. The number of CPU hours produced in that year in 370/158 equivalents was 626.

In FY1979, the total budget of the University was $570,840,597. The A&G budget was $28,680,271 or 5.02% of the total. ADP was a budget of $9,170,000 or 1.61% of the total and 32.0% of A&G. The number of CPU hours produced in that year in 370/158 equivalents was 7,040.

The compound rates of growth (1971-1979) tell a fascinating story:

Total Budget	7.88% per year
A&G	2.41% per year
ADP	8.25% per year
CPU hours	35.32% per year

Clearly the increase in CPU hours is not the single variable that has allowed A&G to be held down. Any of our administrative units that has experienced a lid on new programs and has had to respond to enormous increases in paperwork will tell you that people are also more productive and that many devices like copiers and mag-card typewriters and electronic cash registers have produced gains perhaps even in excess of terminals and computer products. Also, equally clearly, the measure being used (A&G as a percent of total) when applied to productivity, has inherent deficiencies, many of which are fairly obvious. However, data processing productivity is not subject to many conceptual or measurement problems. In 1971, the University produced 626 370/158 equivalent CPU hours at an overall (hardware/people/supplies) cost of $7,766 per hour. In 1979, it produced 7,040 370/158 equivalent CPU hours at an overall cost of $1,302 per hour. Assuming the outputs can be used effectively, productivity has clearly increased.

Next, two specific applications of data processing technology at the University of Illinois, which are expected to increase administrative productivity are discussed. The first is TMIS, Technicon Medical Information System, which will be central to management of our 500 bed teaching hospital. The second is AFIS, Alumni Foundation Information System, which will be the core of an Office of University Development.

TMIS

The University purchased from Technicon Corporation the structure of TMIS, along with access to specific applications in other hospitals and the services of an implementation team. TMIS is an on-line order-communication-reporting system which handles financial management (patient billing and hospital financial management), admitting, nursing, medical staff and departments, pharmacy, laboratory, radiology, clinics, and other ancillaries, as well as providing information for reports to outside agencies.

Change and development in both application and hardware are necessary to fit the system to the University of Illinois Hospital. Mandatory changes in the drug formulary, types of tests, and billing for Medicare and Medicaid patients reflect the hospital's unique academic environment, range of services and patient mix. Other developmental work will relate the system to the organization of University and hospital departments and to the geographical and organizational decentralization of the institution. Lastly, some application changes are being made to incorporate automated systems now used in the hospital.

The system is being phased in over 18 months. As part of the plan to provide the best service, continued refinements and changes will be made long after it is up. The completed system will have 350 terminals and printers at approximately 150 sites (500 miles of cable) on the Medical Center campus.

TMIS was originally designed to run on a self-contained hospital data-processing system, with equipment now several generations old. The University Hospital is comparatively large and sophisticated, part of a very big university, and has access to a larger, more complex computer. As a result, Technicon and UI are doing some significant work to change the environment and the system. TMIS was originally written for DOS running on a 370/158. The 168 does not support native DOS, so for the short term we are running DOS under VM on one of the University's 168's. Most of TMIS is then brought up in this environment. For the long term, the University and Technicon are developing an interface so programs can run under MVS or any similar system, rather than DOS — a fairly unusual arrangement.

TMIS at the University is an extremely complex system, and one that will provide immediate response to requests for information, reports, records, and bills. Clearly the administration of the hospital should be more efficient and productive when supported by this system.

AIFS

This system, designed by Arthur Anderson, Inc. and the University of Illinois, meets the requirements of the University, the Alumni Association, and the University Foundation for data on gifts, pledges, donors, and Alumni Association members. The data base is on-line, and can be updated and edited on-line; batch processing of reports and information requests is done at night when the system is down. AFIS will have 22 terminals at seven sites when it is fully operational, and the data base will contain the records of 250,000 individuals.

The system provides accounting and recordkeeping services for the units it serves as well as management support in the form of eighty to one hundred different reports; AFIS permits an exceptionally great range of data manipulation. It will provide information upon which sophisticated fund-raising campaigns can be based, tracked and evaluated.

The integration of alumni and gift records makes the system useful to several units of the institution, and provides the core of a projected University Office of Development. This successful application of technology supports an emerging, consolidated, institutional effort in an area which can greatly benefit the University. Simultaneously, the units served by the system are undergoing functional reordering and streamlining which was sparked by the emergence of the system.

These two major new systems characterize the developing use of technology to improve productivity. They are not the only such large scale systems in use in higher education. For example, the University of Illinois, like a number of other universities, is engaged in the development of an entirely new financial management system which, when completd, will touch almost every corner of the University in fundamental ways. And one of the underpinning design requirements is administrative productivity. The system sets that objective for departments and source data as well as for all reporting, accounting, and planning.

There are two other areas in which information system technology should provide significant gains in productivity. The first is compliance with institutional, state and federal requirements, e.g., audit, A-21, EEO, and Affirmative Action. The second is what might be called communication management, and the prototype structure is the "electronic office."

Compliance

Response to compliance requirements has become increasingly burdensome to institutions of higher education — though they are certainly not the only organizations which bear that burden. Automated information systems constitute the most promising means of response and are in fact responding now in many institutions across the country. For colleges and universities beginning to examine such solutions to the problems of compliance reporting, the news on the technology front is good. The increasing availability of sophisticated software packages for such purposes will decrease in-house development costs. Hardware is becoming less expensive. Time sharing, system sharing, and distributed processing — all coming into wider use — make it possible to install data processing which is tightly focussed on specific needs without creating an organization from the mainframe up.

Collection and reporting of data to demonstrate compliance and accountability are significant tasks for administrators in education, and will most likely increase in complexity and extent. Financial accounting systems will make institutional responses to auditors (internal and external), legislators, trustees, and our own managers more prompt and inclusive. Student and staff personnel record systems can make reporting on affirmative action and equal employment opportunity compliance more manageable. A-21 reporting on federal grants has nearly become a profession in its own right, but payroll, personnel, and accounting systems can be modified to capture and reformat necessary information for reporting. Proper application of technology will help administrators meet their responsibilities in these areas.

Electronic Office

Communication management in the office, the use of more technologically sophisticated equipment and techniques, should also increase administrative productivity. It begins at the clerical and support levels with printing and copying speeds greatly increased; with electronic transmission of information and documents for storage, printing or copying at a distant site; and with storage of information for retireval in computer report format or correspondence/document format.

Just as conference calls are commonplace today, teleconferencing may well become a commonplace of tomorrow. Those important, sensitive meetings among seven representatives from their side and seven from ours — meetings that required three hours of travel time, reimbursement for three meals and a hotel room plus loss of productivity at the official workplace — may soon be held in our teleconference room and theirs, where a televised image will complete the geographically distant half of the meeting.

RESOURCE SHARING

Now let's turn to resource sharing, the second major area on which the role of technology is both essential and highly beneficial. Here are some examples of systems in place which make documentable improvements in service or function through sharing or pooling various resources.

LCS

This system provides on-line automated circulation and searching capability in member libraries, with central computer support. Information access between and among members permits large scale sharing of library materials. LCS (Library Computer System) was developed at The Ohio State University, and adopted for use at the University of Illinois in 1977. Adaptations have been and continue to be made, to fit the system to the needs of UI. The libraries of the University have completed conversion of their shelf-lists (2,315,405 records) to machine-readable form, and fourteen other academic libraries in the state, public and private, will have their records (approximately 2,521,000) converted and be using LCS by the end of 1980. The 18 state regional libraries are also members of the system with search and borrowing privileges.

Four hundred terminals will be in use primarily by library staff, when the system is completed. Additions; edits; searches by title, author, or catalog number; patron information and notices; and circulation statistics will be available from the system. Materials may be checked out or renewed by telephone at some sites. A Library Delivery System complements and completes LCS. Batch processing is done when LCS comes down each midnight. Patron notices are produced at that time, and at least 90% of data maintenance and any needed program maintenance are also performed.

Initially, LCS was to serve only the University of Illinois libraries, and was running on a 360/75 at one campus. However, encouragement and funding from the state (with support from Illinois Board of Higher Education) permitted us to plan for, justify, and acquire larger computer capability and extend services to the libraries of more institutions. The transfer from the 360/75 to the MPed 168s took place without interruption of extant UI library service and with additional service gradually being undertaken for other schools.

Technology produced the immediate LCS response to a patron. A system that answers, where is it? Is it in? Can I check it out? A few seconds after the question is asked, makes a lot friends. Libraries in each part of Illinois have or will have access through LCS to collections throughout the state, the kind of access traditionally associated with ownership of a collection. As acquisition budgets shrink and book prices rise, library resource sharing becomes more attractive and to some degree inevitable.

IEC/MICC

Sharing intangible resources, such as expertise and purchasing power, as well as tangible ones is exemplified in the Illinois Educational Consortium (IEC) and its offshoot, the Mid-Illinois Computer Cooperative (MICC). IEC is a not-for-profit corporation established in 1972, whose members are the four Illinos public systems of higher education. Its purpose was initially to advance the development and use of computing technology and information systems as a means to improved management and more effective education. Over the years its purpose has become more general: to support and advance the collective activities of institutions of higher education in Illinois as a means to improved management. Resource sharing and cooperative programs are preferred methods for achieving these purposes. IEC has developed programs in collective purchasing, financing, leasing, and brokering of computing equipment. It also offers its members consulting services in planning, organization, and equipment purchasing.

MICC was formed in 1975 to provide remote time-sharing computer services for instruction and research. Currently it runs on a CDC Cyber 730 system, which supports over 300 interactive terminals and nine remote RJEs. The individual institutions using MICC in FY1980 consumed 210,000 terminal session hours. Time on the computer is available — and used — seven days a week.

MICC leases both its hardware and telecommunication lines and equipment. It is also relatively independent of institutional budgeting and administrative procedures. As a result it can be extremely responsive to the needs of its clients by reconfiguring its system at short, regular intervals. This flexibility is essential if MICC is to tailor its system to the changing needs of the institutions it serves. That same flexibility is one of the resources MICC users share.

Clearly, for a single institution, or even a system, to assemble its own resources on the scale of IEC resources is extremely difficult. It is sensible, and in this case effective, for IEC members to pool their dues and service charges to procure the services provided by IEC and MICC.

EDUNET

Another means of resource sharing and exchange is networking, and an example of success in this mode is EDUCOM's EDUNET. This network arranges the supply of computing materials from prominent university computer centers and provides services which permit users elsewhere to identify, access, and apply these resources. EDUNET does not have a computer; it is a marketplace and clearinghouse which disseminates information about computer resources, encourages the use of such resources, and takes advantage of improving technology to bring the resources within reach. The computer resources with which EDUNET deals are of service to administrators, students, academics of every level, and computer center personnel — EDUNET is itself an institutional resource.

PLATO

This system is a cost-effective computer-based educational system with sufficient power and flexibility to provide high quality interaction. The system currently supports approximately 1,100 terminals, controlled by a central computer system, at approximately 200 sites. The terminals display graphics, symbols, alphanumerics, animation, and rapid selective display writing and erasing. They may also incorporate a slide selector, a music synthesizer, and a touch-sensitive screen, among many options. The system has developed into a national computer-based information and communication network, but it is the instructional aspect of the system that is discussed here.

The acronym stands for Programmed Logic for Automatic Teaching Operations. The system provides automated means for individual and individualized student instruction while serving large numbers of students simultaneously. The effectiveness of PLATO lessons can be evaluated easily, and in many ways, since student response data are stored as they are produced. Students have access to 7,000 hours of instructional material in 150 subject areas. A number of commercial applications of the system have also been made.

Both PLATO lessonware and the system as a whole are resources which are shared. The best authors, instructional methods, and displays are sought and made available to users. The flexibility of the system permits great curriculum variation by the teacher, easy revision by the author, and excellent communication between the two. The attributes of the system — screen capabilities, response time, inter-terminal interaction capabilities, programming laguage, on-line research — make it attractive to users for instruction-related purposes. A greater number of users, increasing system efficiency, together with high reliability enable the cost of PLATO to be quite reasonable.

COMMENTARY

The role of technology in colleges and universities can be significant and successful. However, the particular forms in which technological applications appear at any institution are the result of individual decisions; generic prescriptions have little value here. Nevertheless, some general principles might be considered with respect to decisions about the use of computer-related technology.

First, leadership and imagination are necessary. Successful organizations of all kinds, including educational institutions, are characterized by vision, by being ahead of changing circumstances. Often, if one waits for a technology to be proved by demonstrated cost/benefits before proceeding with development, the particular process in question approaches obsolescence before it can be successfully applied. Conversely, the simple availability of a new device or gadget does not in and of itself constitute evidence to justify acquisition or implementation. The decision process therefore largely hinges upon judgments about the future.

A second point is that there must be a judicious balance of planning and control with entrepreneurship and experimentation, a difficult position to manage. Most people seem to fall in one camp or the other, and a great deal of effort is expended arguing over or protecting one's point of view. There are great pressures to centralize planning, control and sometimes operations of computing centers. In many states this pressure has caused state government to become involved in such activities. Good arguments exist in support of this position. The concepts of centralized evaluation, standardization, compatability, reduction of redundancy, training, financing and planning are sound in theory; the outcomes are often less useful than that theory implies because of the efforts of bureaucracy. Individual initiatives and experiments can enhance evaluation of alternative systems and often induce breakthroughs in software or systems that advance the state of the art. However, too much independent exploration brings management and certainly state agencies to perceive the activity as unorganized and therefore suspect.

With respect to this issue, management should overtly consider a reasonable balance between these two positions. Included in this compromise relation are such issues as mini/micro processors, word processors and advanced copying machines. In different words, one cannot control all related technologies centrally or initiatives will be stifled and cost-effective systems missed. Nor can one ignore central planning and review, or confusion and redundancy will reign.

The final principle for consideration is another judicious combination, patience and persistence. A good principal to keep in mind is the accomplishment-to-friction ratio. If one pushes too fast the friction brings up the heat and the price for accomplishment is too high. Even more important, the perception of benefits goes down when the heat goes up, causing the value of the accomplishment to go down. This combination of events can bring the value of the accomplishment-to-friction ratio very close to zero. Curiously, this measure has different values at different times in different organizations, depending on a wide range of issues and personalities. Each organization needs to find a process whereby the value of this ratio can be sensed and managed.

There is measurable and demonstrable evidence that the productivity of administration and the sharing of resources can be improved by using data processing technologies in university applications, even though one can argue about the best measures and speculate about concepts such as improved decision making. But all the traditional functions of management planning, organizing and controlling are necessary to manage this technology; technology as an independent concept will not just "somehow" improve management. If we handle technology wisely, it will provide continued and greater help in solving the management problems of today and tomorrow.

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Implications of Advances in Information Science and Technology for Institutions of Higher Learning

H.L. Resnikoff, National Science Foundation

Less than a dozen weeks have passed since the *Global 2000 Report to the President*[5] was published. After more that three years of gestation, it flared like a nova on the editorial pages of the world press and then, like a nova, rapidly vanished from view. Some heard something about it, although few are likely to have read it. The *Report*, prepared by the Council on Environmental Quality and the Department of State with the assistance of eleven other federal agencies, paints a disturbing picture of a world now only two decades — less than a generation — away; a world in which we and our children will live, and for which our academic institutions must prepare them and their children.

If present trends continue, the *Report* asserts,

> ". . . the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now. Serious stresses involving population, resources, and environment are clearly visible ahead. Despite greater material output, the world's people will be poorer in many ways than they are today.

For hundreds of millions of the desperately poor, the outlook for food and other necessities of life will be no better. For many it will be worse. Barring revolutionary advances in technology, life for most people on earth will be more precarious than it is now — unless nations of the world act decisively to alter current trends.

The world's population will grow from 4 billion in 1975 to 6.35 billion in 2000, an increase of more than 50 percent. Ninety percent of this growth will occur in the poorest countries. . . . The large existing gap between the rich and poor nations widens. . . . During the 1990s world oil production will approach geological estimates of maximum production capacity, even with rapidly increasing petroleum prices. . . . For the one-quarter of humankind that depends primarily on wood for fuel, the outlook is bleak. Needs for fuelwood will exceed available supplies by about 25 percent before the turn of the century. . . . Significant losses of world forests will continue over the next 20 years as demand for forest products and fuelwood increases. . . . The world's forests are now disappearing at the rate of 18-20 million hectares a year (an area half the size of California). . . . Regional water shortages will become more severe. In the 1970-2000 period population growth alone will cause requirements for water to double in nearly half the world. Serious deterioration of agricultural soils will occur worldwide, due to erosion, loss of organic matter, desertification, salinization, alkalinization, and waterlogging. Already, an area of cropland and grassland approximately the size of Maine is becoming barren wasteland each year, and the spread to desert-like conditions is likely to accelerate.

Atmospheric concentrations of carbon dioxide and ozone-depleting chemicals are expected to increase at rates that could alter the world's climate and upper

> atmosphere significantly by 2050. Acid rain from increased combustion of fossil fuels (especially coal) threatens damage to lakes, soils, and crops.
>
> Extinctions of plant and animal species will increase dramatically. . . . Perhaps 20 percent of all species on earth will be irretrievably lost as their habitats vanish, especially in tropical forests.
>
> . . . This, in essence, is the picture emerging from the U.S. Government's projections of probable changes in world population, resources, and the environment by the end of the century. . . . They do not predict what will occur. Rather, they depict conditions that are likely to develop if there are no changes in public policies, institutions, or rates of technological advance, and if there are no wars or other major disruptions.

According to the study, the United States will be relatively better off than most of the other nations, but in an increasingly desperate, volatile, interdependent, and armed world, this is little cause for complacency and none for satisfaction.

It has been said, already, that the *Global 2000* study is flawed, as if other complex products — nuclear reactors, automobiles, electric power transmission networks, economic policies, political processes, and social contracts — are not. But flawed or not flawed, it is probably right, and in any event we cannot afford the luxury of observing the flux of events from a distant planet.

The state of our world that it describes is the measure of all other issues commanding our attention. It is a gauge against which the future role of colleges and universities will be tested, and the context in which new technologies — the theme of this conference — will be assessed. This paper discusses the role of information science and technology within this larger framework, which in part dictates what institutions of higher learning *must* do to preserve their special interests and what they *should* do to further the common interest.

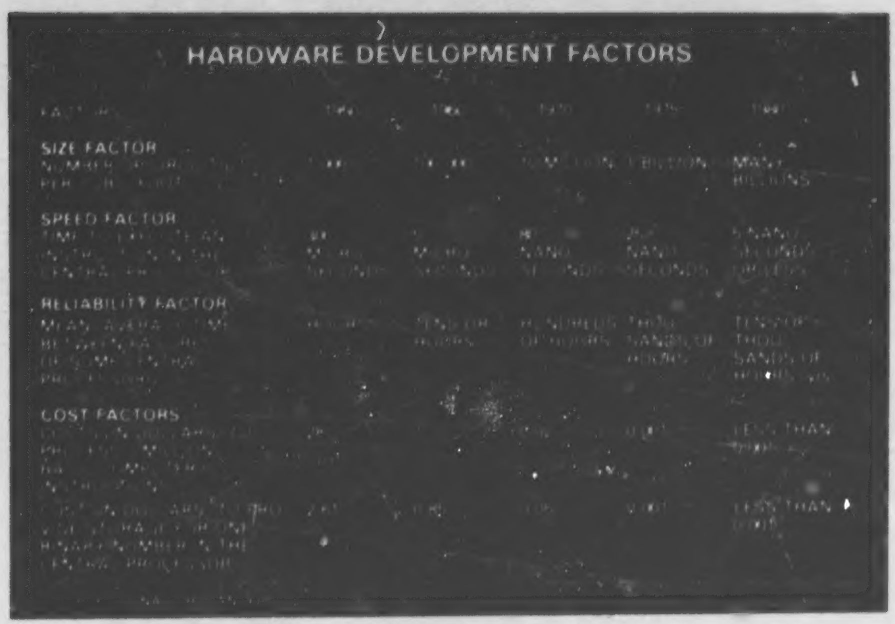
The *Global 2000 Report* calls for prompt and vigorous changes in public policy around the world to face the "enormous, urgent, and complex problems in the decades immediately ahead." As the principal reservoirs of accumulated knowledge, as the main conveyors of that knowledge to our youth through education, and as the primary source of new knowledge through their scholarly and research activities, institutions of higher learning are an important instrument for change and have a unique role to play. Particular areas where colleges and universities can make special contributions are those where problems are new or rapidly growing worse, for the academic world can, when it must, move much faster and more effectively than government.

- The depletion of resources, and the pollution and degradation of the environment call for more knowledge from the physical sciences to understand the problems, and more broadly educated and deeply trained technologists to grapple with them.
- Similarly, the pressures of population and its consequences create societal problems which lend a particular urgency to the rapid advance of the social and behavioral sciences, and to their effective application.
- Finally, if the *Global 2000 Report* is at all close to the mark, life in 2000 will be more materially circumscribed and socially constrained than it now is. Even in the most fortunate nations, even here at home, life will, for a time, become more difficult and mean. Thus the satisfactions of the spirit should play a greater countervailing role than they do today, both for society and for the individuals. Humanistic and liberal education may become more clearly recognized as the quintessential pillar of civilization, and in this regard the responsibility of the Academy to fertilize and otherwise tend the artistic and philosophical flowers of the intellectual garden is clear and unambiguous.

Our universities and colleges bear the principal responsibility for providing the intellectual environment which can stimulate these much needed advances. They also control, through their educational role, the most effective means for rapidly transferring those advances to practice, for the expert graduates of the next few years will be the principal source of the political, social, and technical leadership we need for the future.

The new technologies which most affect colleges and libraries are in one way or another connected with recent advances in microelectronic fabrication, telecommunications, and optical storage, display, and printing methods. These *information technologies*, when organized according to principles derived from the theories of computer design and operation, decision making, information retrieval, cognition, and learning — one may speak of the *information sciences* — are powerful tools for the education, research, and administrative functions of academic institutions, and they create qualitatively new opportunities for inter-institutional cooperative relationships amongst colleges and universities. Other papers presented at this conference have concentrated on particular applications to one or another of these elements, and on specific types of inter-institutional cooperation which the new technologies have made advantageous. In this paper attention is focused on the advances in information technology itself, and on the information science which tell us how to use the technology, in order to better understand their future implications for institutions of higher learning, and the generic opportunities which they provide.

The evolution of microelectronic hardware development can be succinctly summarized (Figures 1-5). During the past 30 years, the linear dimensions of electronic components have decreased by more than a thousandfold, their speed of operation has been multiplied by more than 60,000, their mean time before failure, then measured in hours, is now measured in years. During the same period their cost has plummeted: a computation which costs $1 today would have cost $28,000 in 1950; high-speed data storage which costs $1 today would have cost $2,610 in 1950. These increases in computer hardware performance have not begun to make their impact fully felt at the applications level; it will be years before the marketplace has



HARDWARE DEVELOPMENT FACTORS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SIZE FACTOR					
[illegible]	[illegible]	[illegible]	[illegible]	1 BILLION	MANY BILLIONS
SPEED FACTOR					
[illegible]	[illegible] MICRO SECONDS	[illegible] MICRO SECONDS	[illegible] NANO SECONDS	[illegible] NANO SECONDS	[illegible] NANO SECONDS [illegible]
RELIABILITY FACTOR					
MEAN AVERAGE TIME [illegible]	HOURS	TENS OF HOURS	HUNDREDS OF HOURS	THOUSANDS OF HOURS	TENS OF THOUSANDS OF HOURS [illegible]
COST FACTORS					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	LESS THAN [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	LESS THAN [illegible]

FIGURE 1*

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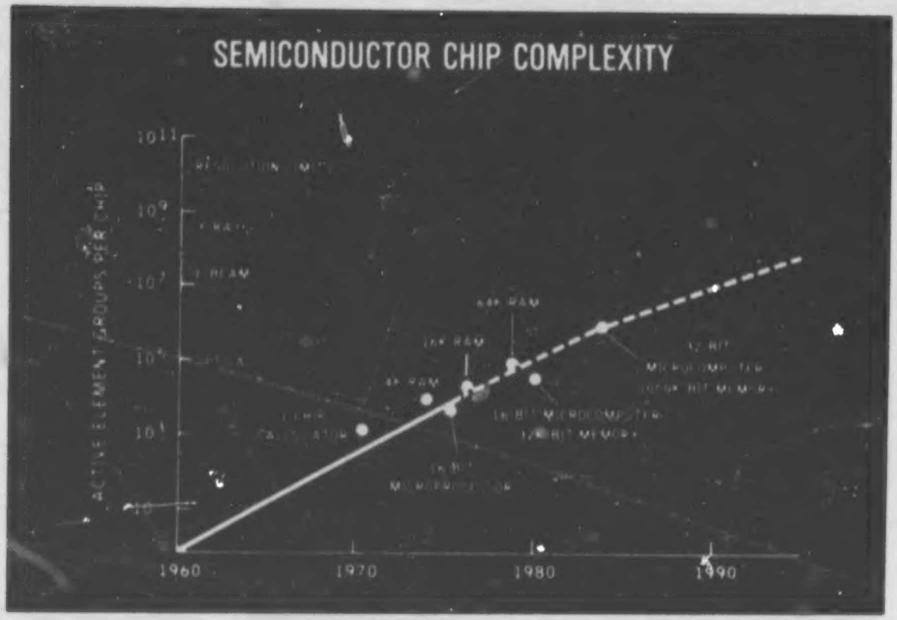
SEMICONDUCTOR CHIP COMPLEXITY
ACTIVE ELEMENT GROUPS PER CHIP
10^{11}
10^{9}
10^{7}
10^{5}
10^{3}
10
1960
1970
1980
1990
64K RAM
16K RAM
4K RAM
1 CHIP CALCULATOR
16 BIT MICROPROCESSOR
16 BIT MICROCOMPUTER 128K BIT MEMORY
32 BIT MICROCOMPUTER 1024K BIT MEMORY

FIGURE 2

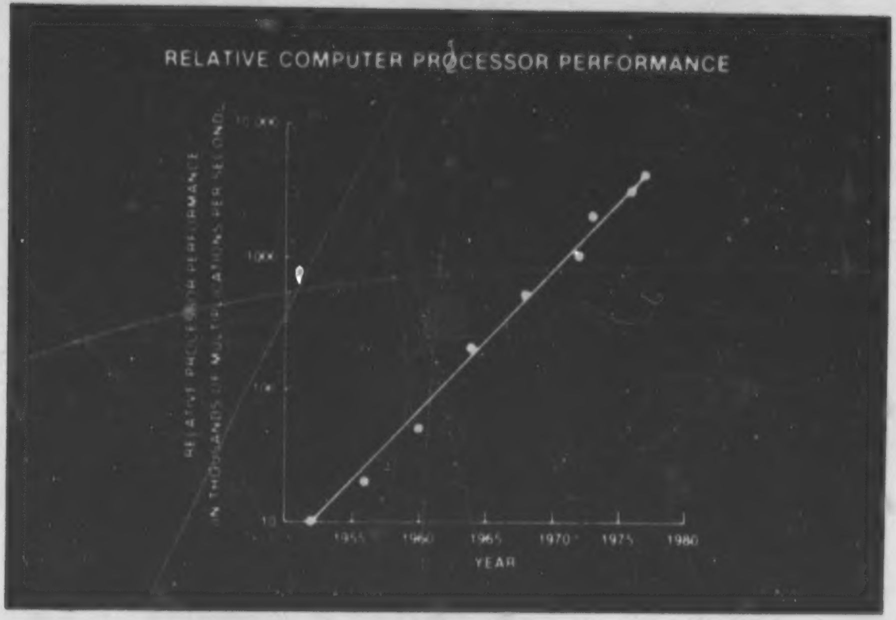

FIGURE 3*

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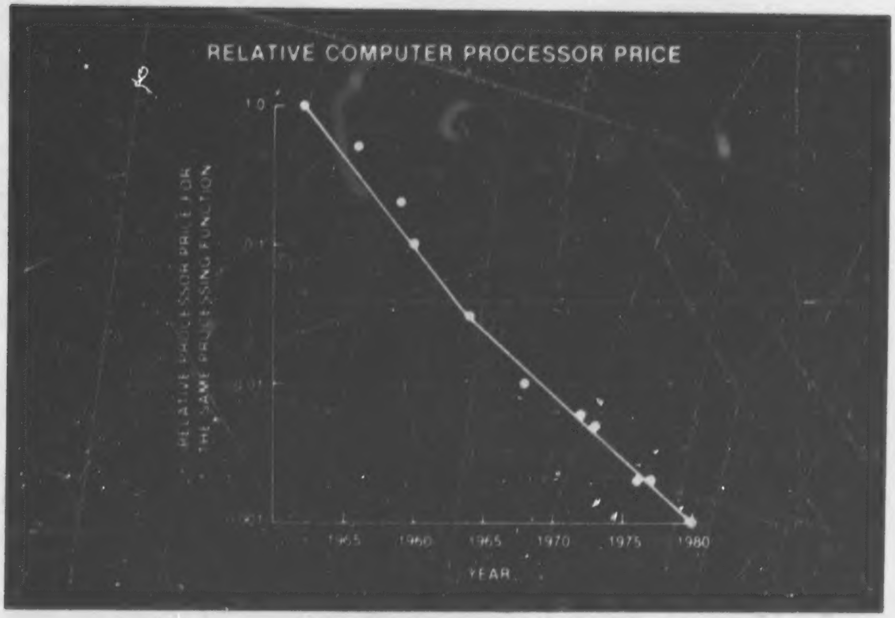

FIGURE 4*

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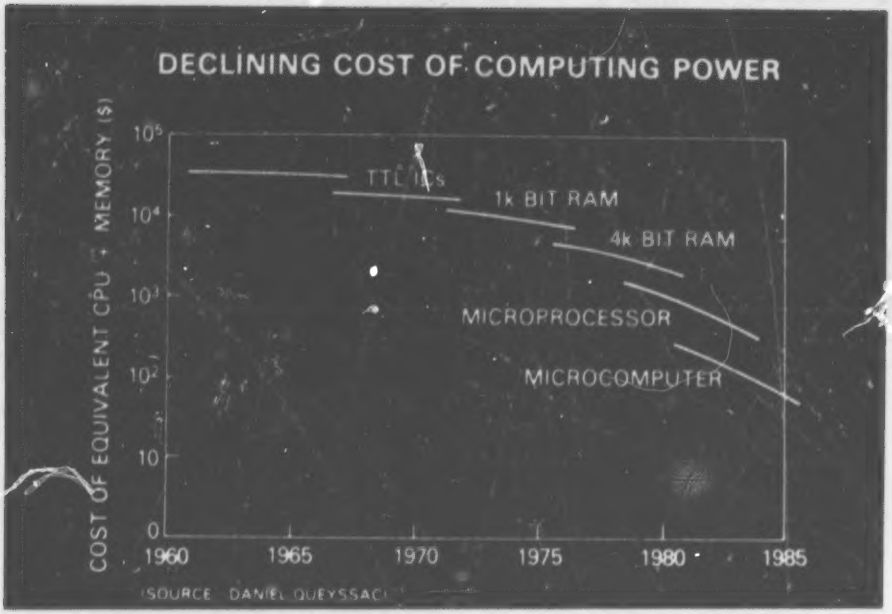

DECLINING COST OF COMPUTING POWER

(SOURCE: DANIEL QUEYSSAC)

FIGURE 5*

©1979 IEEE, "Projecting VLSI's impact on microprocessors," Daniel Queyssac, *IEEE Spectrum.*

absorbed the technology currently available for use. But the pace of development has been continuing, and although the experts expect that the past rate of advance will not be fully maintained in the future, they nevertheless anticipate further very considerable increases in performance and decrease in unit costs.

The significance of these remarkable advances in microelectronics is that reasonably priced machines are becoming available whose computational and logical powers will very soon begin to rival those of biological computing machinery —brains — and, just as machines of the industrial revolution augmented and magnified human muscle power, so too must we expect that the machines of the information revolution will augment and magnify human *mental* power.

More than any other of our institutions those of higher learning have mental activity as both their means and their end; they are the institutions which will feel the ultimate effects of the new information technologies most, and for which the spectrum of opportunities for advantageous accommodation may be greatest.

Lest it be thought that the machine magnification of mental power is a visionary dream unlikely to be realized in the near future, consider the 1979 report of the National Academy of Sciences on thin film electronic microstructures[19] in which Robert L. White wrote:

> "Figure 6 shows a photomicrograph of human brain cells (from the motor cortex) superimposed on a photomicrograph, to the same scale, of a commercially available (Intel) four kilobit random access memory. Note that the bit density of the semiconductor memory is two orders of magnitude higher than that of the human brain. With the further shrinkage of semiconductor structures now in progress the dimensional advantage of electronic intelligence over natural nervous tissue can only increase. It is now possible to

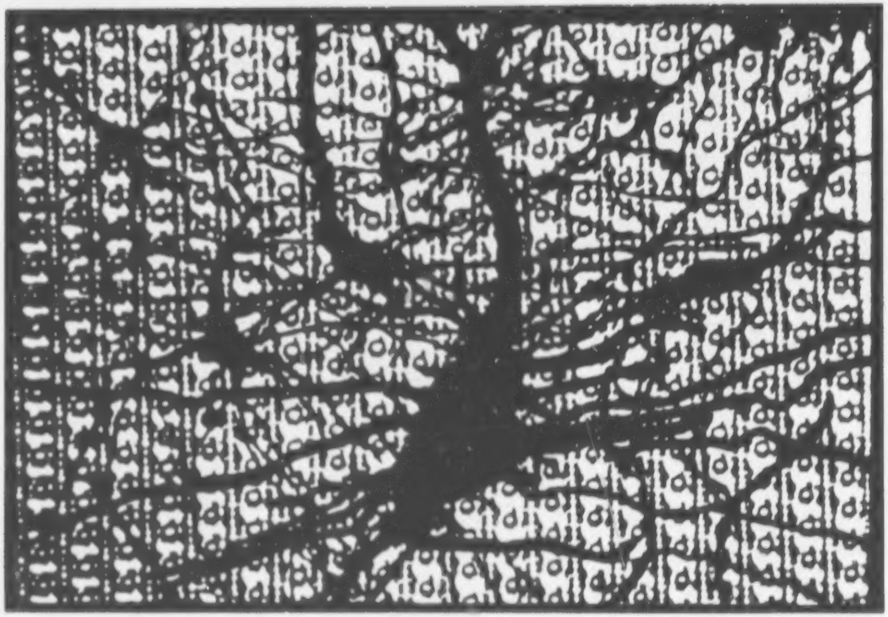

FIGURE 6

Photomicrograph of stained neurons from motor cortex, superimposed on photomicrograph (to same scale) of Intel 4 Kilobit random access memory.)

> contemplate the replacement of defective nervous tissue (e.g., inoperative sensory organs such as the eye or ear, stroke damaged brain tissue) by synthetic intelligence in approximately the same volume and at approximately the same energy cost per transaction."

Figure 7 illustrates a 1 megabit bubble memory chip commercially available today.

We have not yet penetrated far into the world of machine magnified mentality, but there can be no doubt that the threshold has been crossed. "Speak and Spell" and pocket phrase translators, something more than mere toys, mark the first salvos in a general invasion of machine-mediated language activities, heretofore a province uniquely human. Reading machines are beginning to serve the blind in libraries; speech recognition devices are already used to eliminate "the mountain of paperwork" formerly required to trace parts for a Navy missile in an aerospace manufacturing plant;[3] and voice-actuated typewriters are expected to be commercially available from IBM and Matsushita by 1983, and from Xerox and Exxon (sic!) by 1984. They may be in widespread use by the end of the decade, with a resultant need to redeploy more than 1 million typists and secretaries.[4]* The social consequences of these and similar technological developments are only beginning to be considered.[27]

Advances in telecommunications also have been rapid although not quite as spectacular as developments in microelectronics. Substantial reductions in cost and increases in bandwidth have led to a proliferation of national and worldwide networks linking computers and data bases which make practical inter-institutional cooperative relationships which heretofore were not even possible. The most promising are the packet switched networks, which dynamically allocate transmission facilities. They were first conceived in 1964 and realized in practice by the ARPANET, whose first 4 nodes were operating in

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*A recent state-of-the-art survey is[12 cf 17] regarding potential applications.

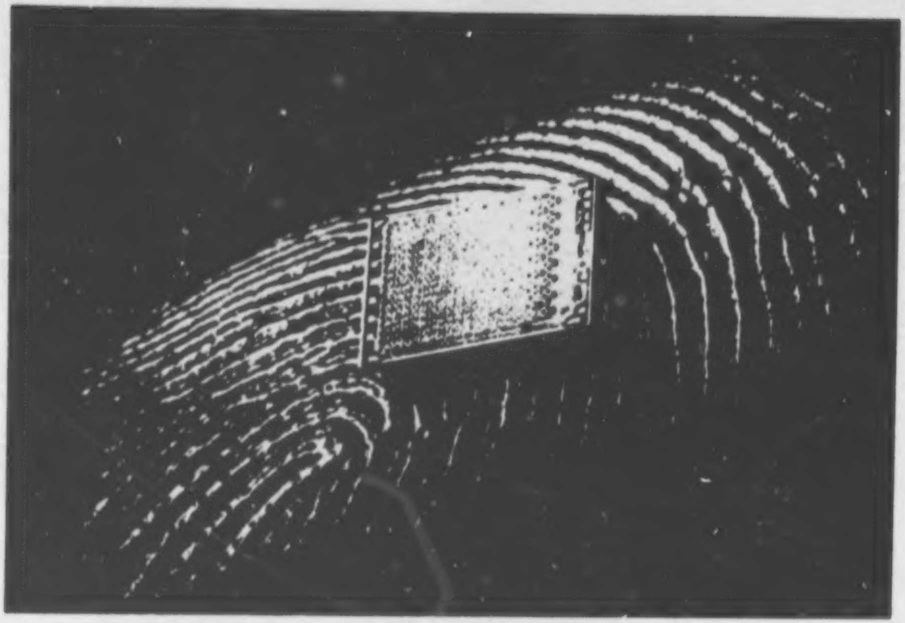

FIGURE 7

December 1969.[22] By 1977 ARPANET had grown to incorporate 111 hosts. The first public packet network service was introduced by Telenet in 1975 and today five companies offer packet based common carrier services in the United States. Packet switching is dependent on low-cost high speed computers and memory buffers to make the dynamic allocation decisions which are necessary to route messages through the network. Its advantages compared with other forms of transmission depends on the nature of the data being transferred but it is 3 to 100 times more efficient than pre-allocation of bandwidth. General purpose packet satellite networks are just beginning to be developed. The first communications satellite, Intelsat I, was launched in 1965 with the ability to handle 240 two-way telephone circuits; captial investment costs were $32,500 per circuit-year over a design lifetime of 1.5 years. Intelsat V, whose launch has been delayed until late this year, has a capacity of 12,500 two-way telephone circuits with a capital investment per circuit-year of $700 over a design lifetime of 7 years. During the 15 years between Intrelsat I and Intelsat V the capacity of a single communications satellite has increased by a factor of 50 and the cost per circuit-year has decreased by a factor of about 45, an investment cost-improvement of 30% per year. The rapid growth of satellite telecommunications is expected to continue, and plans call for the next-generation satellite, Intelsat VI, to be operational early in 1986 with three times the channel capacity of Intelsat V; it would be still larger if the space shuttle could be relied on to launch it.[2]

Worldwide data communications services are expected to double in the next five years, and the United States will continue to dominate with nearly 60% of the activity. This expansion of activity is being driven by overall communication costs which are declining at the rate of about 11% per year.[6,29]

Some implications of these advances in telecommunications technology for information networks were imaginatively discussed by Licklider and Vezza[15] in 1978. They considered nine areas of application of which five, *'basic' applications* (i.e., computing activities), *communication, neopaperwork, management applications,* and *education* directly benefit universities. They note the potential advantages of sophisticated telecommunications techniques for teleconferencing, augmentation of the intellect, modelling and simulation for management planning and decision making, and the application of artificial intelligence techniques for accessing knowledge bases. Each of these topics is currently being actively explored and some of the services are already being provided, for instance by EDUNET; more on these topics will follow below. Lederberg[14] envisionsd the entire conduct of science being changed by the convergence of economical digital telecommunications and powerful computer-aided facilities for accessing data bases and analyzing their content. Based upon his experience with the Stanford-based SUMEX-AIM facility for research in artificial intelligence related to biomedical science, a national shared computing research network established in 1974 which is accessible through TYMNET or ARPANET, Lederberg anticipates the use of computer supported, data-base rich telecommunications as "a qualitatively different method of interpersonal communication from conversation, the telephone, the handwritten memo, the dictated letter, or the published report," particularly well adapted to research management and aministrative affairs, and essentially irreplaceable for communication of the increasingly complex computer programs which are the core of more and more scientific research projects. In the almost three years since Lederberg wrote his article, the increasing number of scientists who share data, computer programs, and general communications by electronic mail systems has grown apace even though the full range of offerings Lederberg contemplated are not yet available anywhere.

At the present time special research telecommunications networks have been proposed for computer science (CSNET) and, as a result of the initiative shown by the Sloan Foundation, for the rapidly developing cognitive sciences (COGNET). Both of these proposed networks are intended to bring a broad variety of research-related capabilities including adequate computing power, electronic mail, data and software exchange facilities, etc. to the widest posssible community of specialists. Neither their precise form, nor their relationship to existing nets such as ARPANET or EDUNET, or to the common carrier networks such as TELENET and TYMNET, are yet clear. Nevertheless, increasing electronic communication and resource sharing among scientists will accelerate the tendency of scholars and scientists to identify themselves with their discipline rather than with their institution. All of the new infromation technologies are reinforcing this trend as they vanquish distance as a barrier to communication. Institutions of higher learning should recognize that this will continue and, rather than resisting or ignoring it, they should plan to promote it and seek to retain their individual identity in other ways, since the cumulative effect of resource sharing will inevitably outpace the private means of even the most powerful single institution.

These are other effects of telecommunications advances which institutions of higher learning cannot afford to ignore. In a recent study,[26] a subcommittee of the National Academy of Sciences evaluated the prospects for more varied telecommunication services for metropolitan areas during the 1980's, noting in particular the special opportunities to bring certain educational services into the home, especially at the lower school level. The report points out that the feasibility, efficiency, and cost-effectiveness (for volume use) of using technology for ther instruction of distant, independent learners has been consistently confirmed by hundreds of experiments and demonstrations. Although these studies have focussed on pre-secondary and adult education, the combination of declining delivery costs and improved methods of computer-mediated instruction is likely to provide effective and competitive alternatives to on-campus college education. Right now is the time for college planners to begin to map their strategies, for it is by no means clear that the college as presently conceived will be the sole provider of telecommunicated education. For instance, Control

Data Corporation has already established Learning Centers throughout the country which, utilizing the PLATO computer-assisted instruction systems, train and educate students in various areas related to computer science. As labor and energy costs rise while computing and telecommunications costs fall, it takes little imagination to foresee the development of this limited capability into a broad-based, high quality, and accredited educational program distributed directly to the home. A 1971 survey found that amongst adults, 23% are interested in non-degree continuing education, 27% are interested in education leading to a degree, and 80% think media and technology could be used to improve access to education.[26]

Steps which reinforce the development of new educational techniques based on computer and telecommunication technologies have been taken by other computer manufacturers and the common carriers themselves. Viewdata, a means of selectively displaying information from a large data bank on a home television receiver,[13] was developed by the British Post Office under the name Prestel in 1978 and, in varied forms, has become the object of demonstration experiments worldwide. Although Viewdata was not initially conceived as an educational device, it does incorporate many of the elements necessary for delivery of education to the home and could serve the Academic environment by providing a variety of information concerning travel, student data, campus telephone numbers and addresses, etc. now only available in less convenient and more labor-intensive forms. The Manitoba, Canada telephone company has begun an extensive Viewdata development with an educational component as one planned objective. The personal computer manufacturers such as Apple and Atari are approaching the same problem from the opposite end, designing educational software supported by their low cost, stand-alone hardware which, although it is now primitive, will rapidly reach the state of the art in computer-assisted instruction. Their continuing investments in educational software, stimulated by the lure of a large market, may lead to improvements which will make machine mediated instruction effective for college level work.

As the capabilities of personal computers[9] and video receivers converge, the interests of the common carriers and of the computer manufacturers will increasingly coincide, thereby further accelerating the pace of development: today IBM advertises that it is "Helping put information to work for people" while AT&T refers to itself as "The knowledge business"; a far cry from their humble origins! Will there be room for institutions of higher learning after these industrial behemoths have comfortably settled themselves in their new roles? Branscomb[7] has suggested that with the advent of electronic systems to distribute knowledge, "the university will be free to give greater attention to the generation of knowledge." But whether it is intellectually or economically possible to separate these two functions remains untested. Will the universities compete to secure their traditional position? Which university will be the first to place a Viewdata *cum* intelligent terminal in every faculty and administrative office? And when will that milestone occur?

Of special significance for institutions of higher learning have been the recent remarkable developments in machine-readable information storage devices. Even with efficient and accurate optical character recognition, large scale storage on paper or microforms will be ultimately impractical because search speeds are inherently slower than the electronic operating speeds of a computer central processing unit. But advances in serially read bubble memory magnetic storage devices and in various optical storage technologies such as videodisks have paved the way for library and other large archival data base applications. Consider the videodisk. Because its large development costs are being paid by the mass market entertainment industry, this technology is coming to the marketplace very rapidly. A videodisk is a platter the size of an ordinary phonograph record which can hold 10 billion bits of information, approximately equivalent to the content of 2000 ordinary books.[8] In videodisk format, the contents of the Library of Congress could be stored on shelves on one wall of an ordinary sized living room. The full text of the 1/4 million articles and reports published on energy research during the past five years could be stored on videodisks in a two cubic foot "knowledge cabinet" supporting a $750 videodisk player and next to a $2500 intelligent terminal which would provide effectively immediate access to the entire archival literature of a professional field.[23] Individual disks reproduced in quantity cost approximately $10. This read-only storage technology is appropriate for large files which are of sufficiently general interest to require the "publication" of hundreds or thousands of copies, thereby distributing the initial production setup costs amongst the users. Library applications are precisely of this type, so one should expect the early appearance of videodisk technology in the distribution of scientific and technical journal literature to institutions of higher learning and corporate research libraries; thereafter, its spread to other special disciplines, and finally, to the retrospective library holdings.

At the same time, a videodisk on which the user can write (but not erase) is in laboratory development. Such "writable" disks will be available soon and will offer an inexpensive and convenient way for offices and computing centers to maintain their permanent files. One videodisk could hold the contents of perhaps 3 million pages of office correspondence and provide the means for more rapid and successful retrieval of particular documents than present paper-based methods allow. One videodisk might even be able to hold all of the papers a university produces in a year as it attempts to comply with A-21 and other government regulations! But let it be noted that high-density storage carries with it the risk of a total loss of records by fire or theft, and poses special problems of guaranteeing authorized access while insuring privacy.

There are other exciting technological developments which could be discussed: new high resolution color display systems; hard copy output devices which operate at electronic speeds and offer the promise of point-of-use printing; Josephson effect low temperature computers which will futher multiply the power and miniaturize the size of computer central processors;

optical transmission glass fibers capably of carrying 50 million bits per second — "enough capacity to carry the contents of more than 40,000 typical books from the Library of Congress in Washington, DC, to Los Angeles in 1 hour";[7] or, closer to the frontier of technology, the recently discovered nonlinear optical effect which may make it possible to increase computer processor performance a thousandfold at ordinary temperatures.[1] But for those whose primary concern is the application of information technology in the academic environment, it should be clear that the principal problems are institutional and scientific rather than technological. We have enough high-powered technology, attractively priced, to accomplish much more than we now are doing.

The institutional barriers involve complex problems concerning the relationships of college and universities to each other and to agencies of government which cannot be adequately considered here. But let us note that regulatory issues (including copyright law and telecommunications policy), federal accountability and recharge policies, national transborder data flow, public access to information and privacy rights, are just some of the thorny, overlapping, and unresolved issues with which institutions of higher learning must contend when the attempt to adopt the new information technologies.

Let us concentrate our attention on the scientific problems which inhibit taking full advantage of these new technologies. As noted earlier the main long-term consequences of applying information technology will be the magnification of mental power. There are three main types of potential applications in institutions of higher learning:

- Decision-making for administrative operation;
- Machine-mediated instruction;
- Support of research and scholarly activities.

All three share the property that the assisting technology is expected to perform some part of activities which are usually considered to require *intelligence*. Researchers in machine intelligence have made definite strides in recent years[11,18,28; cf. 25] in what some now call *knowledge and engineering*, which is the application of artificial intelligence techniques to practical problems of formalizing decision making the mechanizing collective expert judgment. For instance, now there are chess programs which complete at the master level; a celebrated backgammon program, which mimicing the heuristic methods typically employed by human experts, recently defeated the world champion in a series of matches; and a medical diagnostic and course-of-treatment program resident in a California hospital diagnoses and prescribes treatment for a large class of bacterial pulmonary infections based on laboratory test data as input, competing favorably with the interns it may ultimately replace. Mineral resources companies have come to rely on programs which incorporate the knowledge of a number of successful exploration geologists and synthesize their expert judgment processes. The present successes and future prospects of these "expert systems" has led the major oil exploration and production firms to assume an unexpected role as leaders in corporate-funded machine intelligence research. Finally, the first non-human co-author of a refereed scientific publication, the famous DENDRAL system,[11] which computes structural descriptions of complex organic compounds from their mass spectrograms and related data, is but the harbinger of greater participation by intelligent machines in the processes of discovery and invention.

Nevertheless, the current state of the art in machine intelligence does not penetrate very deeply into fundamental questions[16] about the nature of knowledge: how it is represented in the brain and how it might be represented in a machine; what the relationship is between knowledge representation and language structure; how patterns are classified and recognized; and how information and knowledge should be organized to permit them to be retrieved. There has, however, been a notable surge in research activity on these and related problems in recent years and now there is real hope for significant progress because, for the first time, microelectronic technology is providing scientific instruments of sufficient power and complexity to probe, model, and test the phenomena of information and intellect.

These new scientific instruments — powerful computers —whose primary practical use is to magnify or substitute for mental power, are rapidly spreading through society. This raises still another issue which should be briefly noted here.

The driving force of technological innovation in microelectronics is sustained by the capital accumulated through ever increasing use of electronic logic functions in society. Figure 8 displays how their use has grown since 1960, and how it is expected to continue to increase through 1985. Today, there are about 50,000 functions per capita in use in the United States; that may grow by a factor of 10 in the next five years. It is likely that each person in the United States will personally command the capabilities of a powerful computer by the end of the decade. What personal needs can these complex machines possibly serve and, more to the point, who will program them? In 1955, software costs were only about 15% of total information system costs, but by 1985 software is expected to account for almost 90% of system costs (Figure 9). With the number and size of computing machines growing, where will the programmers be found to create the necessary software? Many of your institutions are already experiencing this problem. Figure 10 shows how the number of programmers, about 1 million in 1976, places critical constraints on the types of machines that can be successfully marketed in quantity. Above the programmer population limit, consumer calculations, electronic toys, and word processers hold the field virtually uncontested. But consider the dynamics which underlie Figure 10. As time passes, computing cost falls and computing power rises. This means that computers of all types are moving along the band from lower left to upper right. All of the advances which we have considered depend on breaking through the programmer barrier.

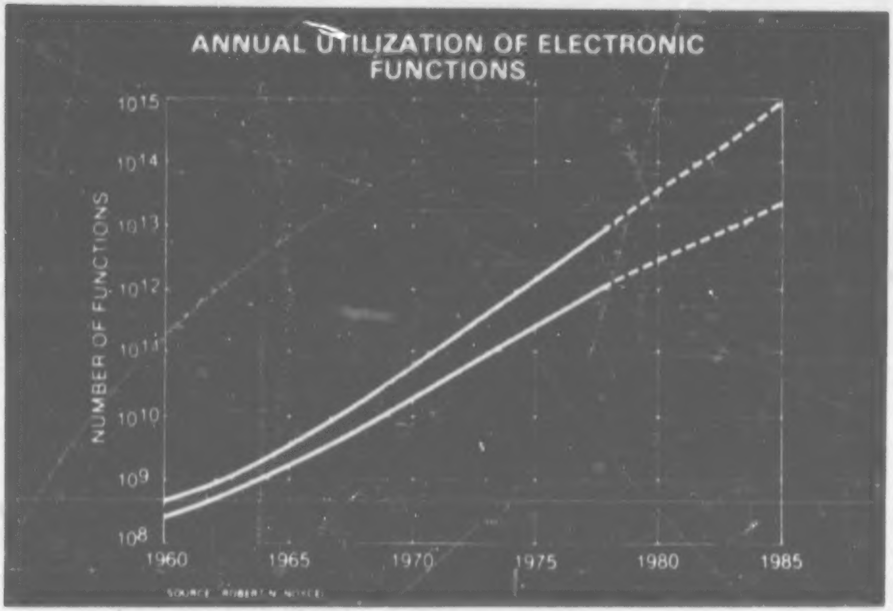

FIGURE 8*

*"Microelectronics," Robert N. Noyce. Copyright 1977 by Scientific American, Inc. All rights reserved.

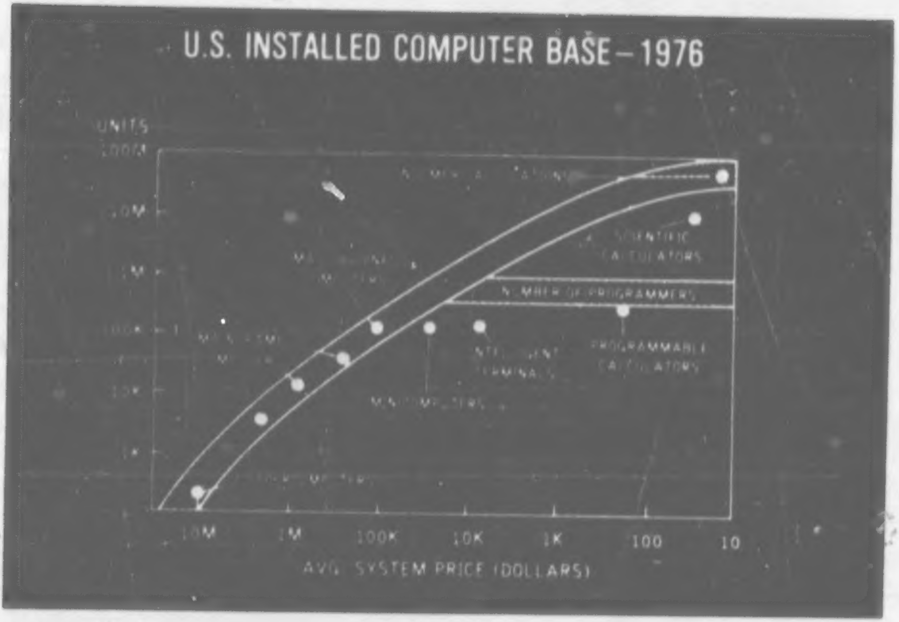

FIGURE 9*

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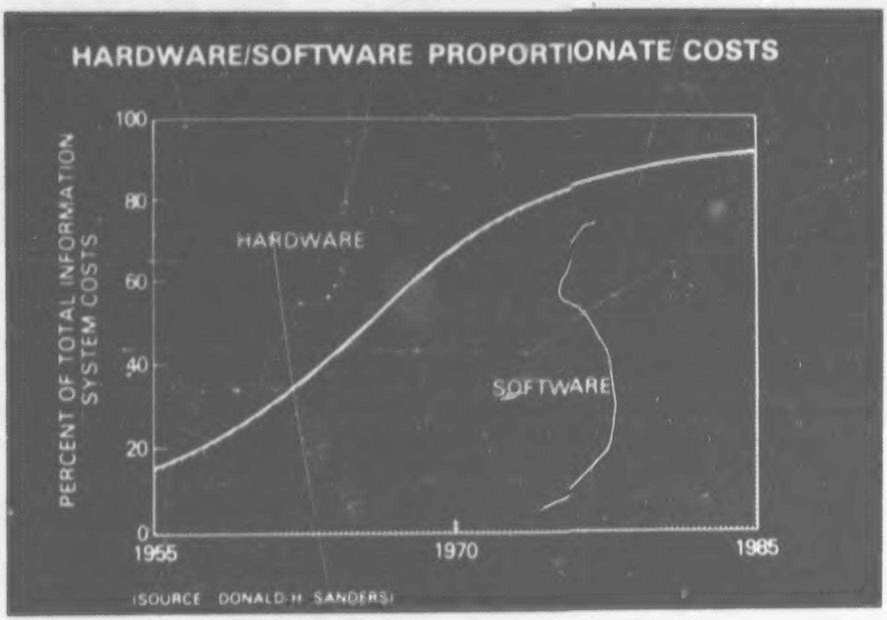

(SOURCE DONALD H SANDERS)

FIGURE 10

But this essentially amounts to the automation of programming itself, and in particular, it depends upon the ability of an automatic programming system to comprehend and make precise the tasks communicated to it by a person. Although this is of course just one example of the magnification of mental power, it is a crucial one. The economic realities of the microelectronics and computer industries will force increasing resources to be brought to bear on the problem of automated programming, and this in turn will stimulate efforts to solve the general riddle of intelligence.

It is time to return to our larger theme. The authors of *Global 2000* suggest that a future more heartening than the one they project can only result from changes in public policies, in institutions, or in the rate of technological advance. Policies and public institutions are generally resistant to rapid change, and while they may offer the only long run hope for solving the big problems facing the world, they cannot be relied on to substantially improve circumstances during the next 20 years. In the short run, as institutions begin to adapt and policies are modified, the world will be forced to rely on technological change to carry through perilous times. But the rate of technological change that would appear to be required is relatively great. The question arises whether the present rate of advance can be increased, and here the special role of the information technologies and information science — and perhaps a new role for institutions of higher learning — emerges. By augmenting intellect, by magnifying mental power, by solving the riddle of intelligence, the rate of technological change may possibly be brought up to match the world's needs.

This is amongst the most noble of intellectual challenges; it is also one of the most essential for society.

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